BRITISH COLUMBIA SEABIRD COLONY INVENTORY: REPORT #1 – EAST COAST MORESBY ISLAND

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ABSTRACT

Seabird colonies along the east coast of Moresby Island were surveyed between 1982 and 1986 as part of the British Columbia Seabird Colony Inventory Program. The goal of that program was to establish baseline estimates of breeding seabird populations in B.C. using standardized survey techniques to allow future comparisons and monitoring of those populations. Total or partial counts were performed on all colonies of surface nesting species, and on small storm-petrel and alcid colonies. On large colonies of burrow nesting species, distribution and total numbers of burrows were determined using systematically spaced quadrats. Burrow occupancy rates were determined with a variety of sampling schemes on large alcid colonies but were not determined on storm-petrel or small alcid colonies. Detailed survey methods and results for each island are presented.

The region supports over half a million breeding seabirds, including 238,000 Ancient Murrelets (Synthliboramphus antiquus), 144,000 Cassin's Auklets (Ptychoramphus aleuticus) and 115,000 storm-petrels (Oceanodroma spp.). The most important concentrations occur in Skincuttle Inlet, on Rankine Islands and around Ramsay Island. Marbled Murrelets (Brachyramphus marmoratus) likely nest in the region but were not surveyed.

RÉSUMÉ

Les colonies d'oiseaux marins le long de la côte est de l'île Moresby furent recensées de 1982 a 1986 dans le cadre du programme de recensement des colonies d'oiseaux marins de la Colombie-Britannique. Ce programme vise à estimer les populations d'oiseaux marins nichant en Colombie Britannique en utilisant des techniques standardisées de recensement, permettant l'étude à long terme de ces populations. Des décomptes partiels ou complets furent conduits dans toutes les colonies d'espèces nichant au sol ainsi que dans les petites colonies de pétrels et d'alcides. Dans les grandes colonies, l'abondance et la distribution des terriers furent determinées a l'aide de quadrats uniformement espacés. Plusieurs méthodes d'échantillonnage furent utilisées pour déterminer les taux d'occupation des terriers dans les grandes colonies, mais les taux d'occupation ne furent pas mesurés dans les petites colonies d'alcides et de pétrels. Une description complète des techniques d'échantillonnage et les résultats pour chaque île recensée sont presentés dans ce rapport.

Plus d'un demi-million d'oiseaux de mer nichèrent sur les îles le long de la côte est de l'île Moresby. On y retrouva entre autre 238,000 Alques à Cou Blanc (Synthliborhampus antiquus), 144,000 Alques de Cassin (Ptychoramphus aleuticus) et 115,000 pétrels (Oceanodroma spp.). Les plus importantes concentrations furent observees dans le bras de mer Skincuttle, sur les îles Rankine et aux environs de l'île Ramsay. Bien que l'Alque Marbrée (Brachyramphus marmoratus) niche probablement dans la région, il n'a pas été recensé.

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INTRODUCTION

The Queen Charlotte Islands archipelago is a major centre for seabirds in British Columbia with over 1.5 million birds of 12 different species breeding at almost 200 sites. A third of this population and 10 of these species currently nest at 78 sites on the east coast of Moresby Island (Fig. EM-1; Table EM-1 p. 250). The region supports 44% of the total population of Ancient Murrelets (Synthliboramphus antiquus) nesting in British Columbia, as well as a significant percentage of the Storm-Petrels (Oceanodroma spp.), Pigeon Guillemots (Cepphus columba) and Cassin's Auklets (Ptychoramphus aleuticus) (Rodway et al. in prep).

Surveys in 1971 (Summers 1974) and in 1977 (Campbell and Garrioch 1979) located most seabird colonies in this region, and provided estimates of nesting populations. Accurate nest counts were made in 1977 for Pelagic Cormorants (Phalacrocorax pelagicus), Black Oystercatchers (Haematopus bachmani) and Glaucous-winged Gulls (Larus glaucescens), providing population estimates to which future counts could be compared (see Rodway 1988). For burrowing species, the 1977 estimates were based on brief explorations, and could only be used to detect large changes in nesting distribution and population size. Historical data and known changes are presented in Seabird Colonies of British Columbia (Rodway et al. in prep.).

The Canadian Wildlife Service began inventories of nesting seabirds in the Queen Charlotte Islands in 1980. Surveys on the east coast of Moresby Island were conducted from 1982 to 1986. The goal of that inventory program was to establish a replicable baseline estimate of all nesting seabird populations that could be used to make effective management decisions, to monitor future population trends, and to identify current and potential threats to those populations. Breeding distribution and populations of Marbled Murrelets (Brachyramphus marmoratus) which likely nest in this region are unknown. Special survey methodology will be required to address the unique conservation problems presented by this species (Sealy and Carter 1984).

This volume is the first in a series of technical reports that present detailed information on the status of nesting seabirds in various regions of the coast, and on the survey methods that have been used to determine that status. The level of detail in this series is intended to facilitate future surveys and research on the coast. We have attempted to provide precise descriptions of colony characteristics and helpful suggestions on the logistics of working on colony islands. Report #1 includes accounts of all islands surveyed between Kunghit Island and Cumshewa Island. The Kerouard Islands and all islands surveyed along the west coasts of Kunghit Island and Moresby Island are presented in Report #2 - West Coast Moresby Island (Rodway et al. in prep.(a)). We have previously produced individual reports on Lyell Island (Lemon and Rodway 1983) and Ramsay Island (Lemon and Rodway 1984), and Gaston and Noble (1985) prepared a report of their surveys on Reef Island. We have edited those reports and included them here to present all the island accounts for the region in a standardized format. Data on surface nesting species from 1986 has been extracted from Rodway (1988), to include all survey data for colonies on the east coast of Moresby Island in this report.

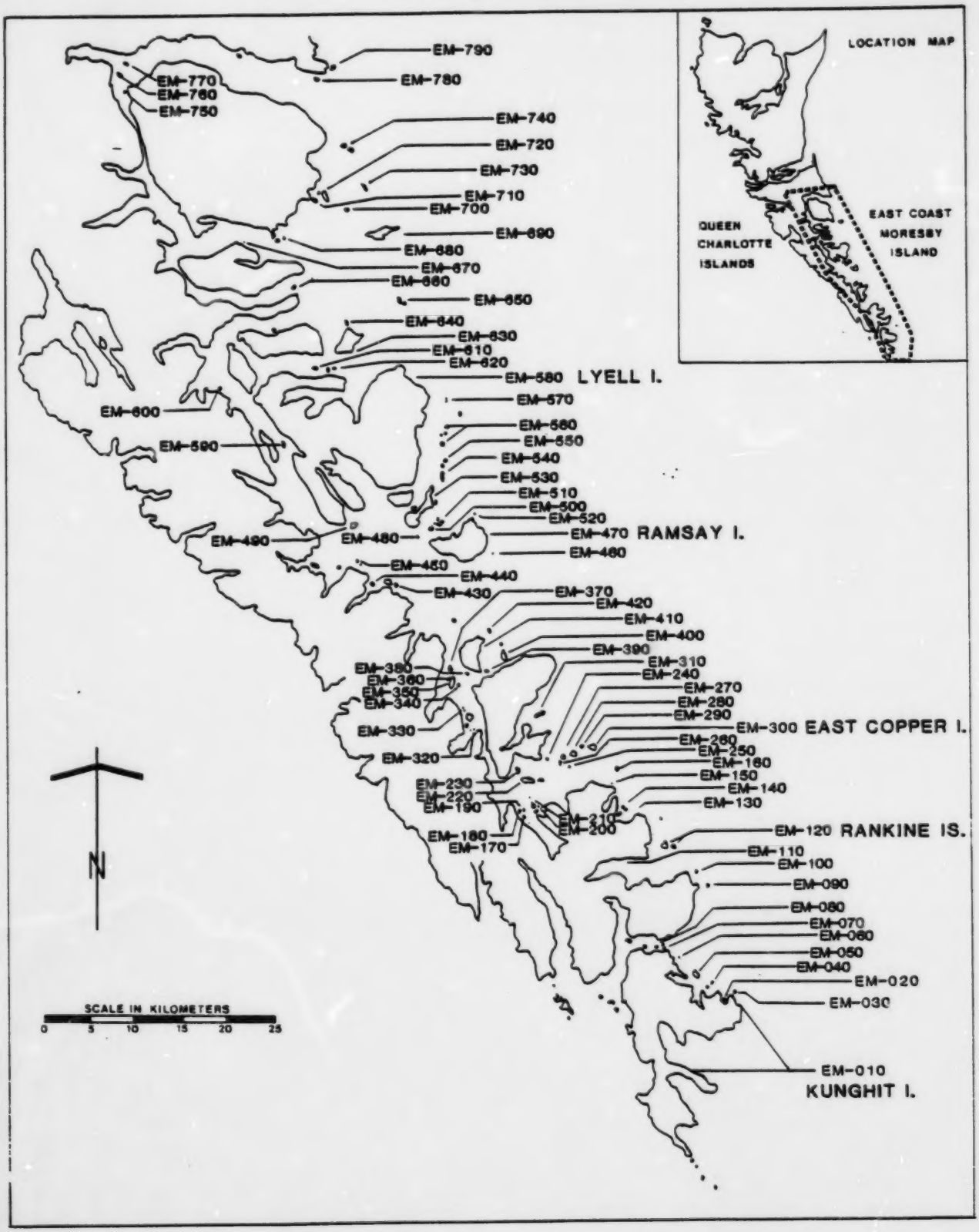

Fig. EM-1. Seabird colonies on the east coast of Moresby Island.

The east coast of Moresby Island has become a popular recreational area, and the south-east coast has recently been proposed as a National Park. Intensive tourist traffic could have an impact on nesting seabirds, and seasonal restrictions on access to colony areas will likely be required to protect sensitive species and sites. The region is potentially threatened by oil development in Hecate Strait and colonies will require adequate buffer zones to shield them from possible accidents (Vermeer and Vermeer 1975; Vermeer et al. 1984). Introduced racoons may be the most immediate threat to seabirds in the region (and in the entire Queen Charlotte Islands), and we suspect that they have already eliminated seabirds from at least three colonies (Sea Pigeon Island, Boulder Island, Sels Islet) (Summers and Rodway 1988). They have recently been sighted on Kunghit Island, and they may be present on the west Limestone Island. They threaten to spread to the many colonies close to the shore of Moresby Island. Their unchecked expansion could devastate seabird nesting populations. This report should provide the technical background with which to identify sensitive sites, set priorities and determine the scale of seabird conservation problems.

METHODS

Most surveys were timed to coincide with the nesting periods of Ancient Murrelets and Cassin's Auklets (April to June). To census surface nesting species a later survey was conducted in June 1986 (Rodway 1988). Many islands were surveyed before the majority of Leach's Storm-Petrels (Oceanodroma leucorhoa) were incubating, though burrows were prepared and courting adults were present.

Census methods were selected according to the area, habitat, and species of birds nesting on an island (Nettleship 1976). All islands were first explored to determine if nesting occurred. Small islands were completely examined. On large islands the entire perimeter was explored to a distance of 50m from shore, plus frequent sections of the interior up to 200m from shore. If no nesting seabirds were found no further searching was undertaken. If nesting was encountered exploration was continued to determine colony boundaries and the appropriate census techniques.

1. Total Count. Total nest counts were made for Pelagic Cormorants, Black Oystercatchers and Glaucous-winged Gulls, unless nests were inaccessible. Population estimates equal the number of nests counted. For burrowing species, total counts were made when all burrows were accessible and easily tallied during the exploration of the island. This method was appropriate on small islands with few burrows, or on larger islands with scattered burrows around perimeter areas. Population estimates equal the number of burrows counted multiplied by the median occupancy rate (Appendix 1). Nesting populations are estimated differently for surface and burrow nesting species because surface nests are constructed each year and represent a current reproductive effort, whereas burrows can persist for a number of years even when not being used (study in progress on Saunders Island - see Rodway et al. in prep.(a)). Within the text, lists of nests counted use these abbreviations: Emp - empty; E - egg; Y - young; Ad - adult.

Total numbers of Pigeon Guillemots (Cepphus columba) seen around colonies were counted, but no standardized observation techniques were employed (see Nettleship 1976), and no attempt was made to estimate actual nesting populations.

2. Partial Count. On small islands where a total count was not feasible or practical, but the colony area or population was too small to warrant sampling by transects, burrows in representative portions of the island were counted and figures were extrapolated to the rest of the area. Population estimates equal the number of burrows estimated multiplied by the median occupancy rate (Appendix 1).

3. Strip Transects. These were used primarily on storm-petrel colonies that were too small to sample effectively with line transects. Measured strips of uniform width were run at systematic intervals across the colony area, and all burrows were counted within them to give an estimate of the overall density of burrows. Occupancy rate, colony area, and total population were calculated as described below under line transects.

4. Line Transects With Quadrats.

Line transects were used on all large colonies (>1000 pairs) of burrow-nesting species, except on Kunghit Island where time was limited.

4.1. **Transect location.** After the colony was mapped during exploration, equally spaced transects were run throughout colony areas. In areas where the coastline was straight, transects were laid out upslope, generally perpendicular to the shoreline. On smaller islands, or around points or bays of large islands, where the coastline was concave or convex, transects were laid out along parallel bearings to avoid convergence or divergence inland. Such transects were run across the long axis of an island or point, to insure representative sampling of variations in species distribution and burrow density. Transect spacing ranged from 50m to 200m apart, depending on colony and quadrat sizes (see below). We attempted to sample 1% of the area of a colony. That value was the maximum sampling effort we found possible within the time alloted. The first transect was placed half a "spacing" distance from the borders of a colony, and unless the colony edge was at the island shore, a transect was run outside the edge to insure that our mapping was accurate, and to provide a sample of "non-colony" so that changes in colony extent could be reliably interpreted on future surveys. The rest of the transects were located either by measuring the spacing distance along a line perpendicular to the transect bearings (along the shore if this was feasible), or by locating reference points plotted on air photos (for areas where the topography was extremely dissected or impassable).

4.2. **Quadrats:** Quadrats were set at predetermined intervals along transect lines, with the first quadrat at the shore edge of the vegetation, unless that was inaccessible, and the last placed beyond the interior extent of the colony. Plots ranged in size from 3mx3m to 7mx7m, depending on the density of burrowing. The size was selected so that an average of at least one burrow occurred in each quadrat. Low density colonies of Ancient Murrelets often required large plots to obtain burrows within them, while dense colonies of storm-petrels or Cassin's Auklets could be sampled with smaller, more frequent plots (Savard and Smith 1985). Quadrat spacing varied from 15m for 3mx3m plots, to 40m for 7mx7m plots.

Burrows were counted within each quadrat and their entrance characteristics recorded: location (ie, under roots, stumps, logs, grass tussocks, etc.), accessibility (whether it was obscured, or obstructed), and signs of activity (droppings, feathers, etc.), both at the entrance and in the tunnel. Each burrow entrance was explored to one arm's length. If,within this distance, entrances connected into the same tunnel, only one burrow was recorded and the number of entrances was noted. Habitat parameters were measured: distance from shore, altitude, slope, percent and species composition of ground cover, shrub cover, and forest canopy. To place the quadrat in the context of the overall habitat, tree species, percent composition, and average size (dbh), and general terrain features were documented for the area surrounding each quadrat within a radius equal to half the distance between quadrats. Evidence of predation (eggshells, carcasses, feather piles) within each quadrat was recorded (see Appendix VII). Detailed analyses of habitat data are not included in this report but will be presented in subsequent documents.

4.3. **Colony area:** Colony area was defined to include all portions of an island where burrows with recent signs of activity (droppings, feathers, regurgitated food, fragments of eggshell or egg membrane, worn entrances or tunnels, excavation, or fresh nesting material) were located. If burrows were located, but no signs of recent activity were observed in an area, the colony was considered abandoned. If there were no burrows within a quadrat, the surrounding area was searched for colony evidence to determine if the plot fell within the colony and should be used in density calculations. If no burrows were found within a distance halfway to adjacent quadrats along the transect, nor within a lateral radius half the distance to adjacent transects, then that area was not considered colony and the plot data was not used in density calculations. If burrows and signs of activity did occur within this range, then the area was considered colony and the plot data was used as part of the burrow density sample. If active looking burrows were observed in the vicinity of one quadrat, but were absent from the area surrounding an adjacent quadrat the colony boundary was delimitated halfway between the two quadrats, unless an obvious border was encountered. The same criteria was applied between transects. This degree of resolution of colony boundaries was as accurate as time and equipment allowed for extensive Ancient Murrelet colonies. For storm-petrels and Cassin's Auklets, whose colony boundaries were usually less extensive and more discrete, a finer resolution could be obtained, and precise measurements were often possible.

Distance, elevation, and slope measurements taken along the transects, as well as during the exploration, were used to draw colony areas on detailed topographic maps or air photos. The horizontal surface area of the colony was measured on that map with a compensating polar planimeter. Adjusting for slope, the area of the colony was given by:

$$C_s = A_h \quad T^2 \quad (\cos \theta)^{-1}$$

where C_s is the colony surface area, A_h is the area on the map, T is the scale of the map, and θ is the mean slope along the transects. The colony area calculations take into account the average uphill slope, but not the undulations between quadrats or between transects. Therefore our calculations give a conservative estimate of the total surface area available to the birds for nesting.

4.4. **Burrow density:** Counts from all plots within colony area were used to calculate an average burrow density for the entire colony. This average density was used for population calculations. If marked and consistent differences in densities were encountered in different parts of a colony, those areas were separately mapped and individual density rates were calculated. Assigned density classes are unique to a particular colony and cannot be equated to those designated for other colonies. Their purpose is to demarcate areas of nesting concentration within a colony. Densities are quoted plus or minus one standard error. On figures, burrows/ha is abbreviated to b/ha.

4.5. **Burrow occupancy:** The percentage of burrows that actually contained nesting birds was determined by complete examination of a sample of burrows. If an adult, egg, chick, or freshly hatched egg membrane was found, the burrow was considered occupied. Burrows were considered empty if all tunnel branches were explored and none of the above were found. Signs such as a well worn entrance or droppings were not used to distinguish between occupied and empty burrows. Exploring burrows longer than an arm's reach required digging one or more access holes until the end was reached. Excavated holes were immediately patched with sticks and soil. The contents of many burrows were impossible to determine because they extended under roots or fallen trees or into cavities within tree bases. To minimize disturbance, adults were not pulled from burrows except to confirm species identification.

To obtain a representative sample of the entire colony, we attempted to determine the occupancy of each burrow located within surveyed quadrats. Due to time constraints we were often unable to accomplish this. In those cases we selected quadrats from different areas of the colony and explored every burrow in each quadrat selected. The selection process was not systematic (see Methodological Considerations and Recommendations). Occupancy tables within the colony accounts indicate quadrats where occupancy data was obtained. They do not list quadrats where effort was spent but no burrow contents determined. On some colonies, transects were run early in the nesting season before all birds were nesting, and occupancy was determined later in one or two areas. Areas were chosen where burrows were frequent and a sample could be obtained within one day by all workers present. To minimize the bias of selecting likely or easy looking burrows within those areas, we started from a central point and explored every burrow encountered within an expanding radius until we had samples of 20 to 40 burrows with known contents. The size of those areas was not measured. Their locations are indicated on colony maps.

When we had data on occupancy from several plots, we calculated the occupancy rate according to the formula:

$$R = \frac{\bar{x}}{\bar{y}}$$

where x_i is the number of occupied burrows in the ith quadrat, and y_i is the total number of occupied plus empty burrows in the ith quadrat and $\bar{x}$ and $\bar{y}$ are, respectively, the mean of the x_i and y_i over all quadrats.

The variance of R is calculated from:

$$\mathrm{Var}(R) = \frac{\bar{x}^2}{\bar{y}^2}\left[\frac{s_x^2}{\bar{x}^2} + \frac{s_y^2}{\bar{y}^2} - \frac{2s_{xy}^2}{\bar{x}\bar{y}}\right]$$

where s_x is the standard error of $\bar{x}$, s_y is the standard error of $\bar{y}$, and s_{xy}^2 is the covariance of $\bar{x}$ and $\bar{y}$.

The standard error of R is the square root of Var(R).

On small colonies that were not transected, and on transected colonies where an occupancy rate was not determined, either due to lack of time or because our survey occurred too early or too late in the breeding season, we

estimated nesting populations using a median occupancy rate based on data from all other colonies of that species surveyed in British Columbia (Appendix I). We used a median rather than an average rate because occupancy data has been collected from various regions of the coast during different years, and without further studies on temporal and regional variations and the factors that influence them, we considered the median to best represent the occupancy rate likely to be encountered on any island. To calculate a median rate for storm-petrels we only used occupancy rates determined when both species were nesting (end of June to beginning of August; see Vermeer et al. 1988), unless there was only one species present. On some colonies we were too early to determine an occupancy rate for Leach's Storm-Petrels, but were able to obtain a rate for Fork-tailed Storm-Petrels (Oceanodroma furcata). In those cases we calculated population estimates for both species by using the median storm-petrel occupancy rate, deriving the number of Leach's Storm-Petrels by default according to the formulas:

$$P_F = B \frac{F + E \frac{F}{F+L}}{K}$$

$$P_L = BM - P_F$$

where P_F and P_L are nesting population estimates for Fork-tailed and Leach's Storm-Petrels respectively, **B** is the total number of burrows in the colony, **F** and **L** are the numbers of known Fork-tailed and Leach's Storm-Petrel burrows at the time of the survey, **E** is the number of burrows which were occupied, but the species was not identified (e.g. cold eggs), **K** is the total number of burrows sampled, and **M** is the median occupancy rate. We assumed that occupied but unidentified burrows belonged to the two species in the same proportion as identified burrows. The actual proportion would likely vary at different times in the season.

4.6. **Total burrows and current nesting estimates:** The total number of burrows (**B**) is the product of the overall average density of burrows as determined in the quadrats and the total area of the colony. **B** multiplied by the occupancy rate, (**R**) gives an estimate of nesting pairs (**P**). Calculations are quoted plus or minus one standard error.

$$P = BR$$

The variance of P is calculated from

$$\mathrm{Var}(P) = B^2 \mathrm{Var}(R) + R^2 \mathrm{Var}(B) - \mathrm{Var}(B) \cdot \mathrm{Var}(R)$$

The standard error of P is the square root of Var(P). When a median occupancy rate is used to calculate a population estimate, the standard error of the population estimate is derived directly from that for burrow density. This makes the population estimate appear more accurate than it would be if an occupancy rate with a standard error had been determined.

5. Distinguishing species:

The burrows of different species are often mixed. This presents problems for surveyors when burrow contents cannot be determined. Identification of burrows must then be based on indicative signs found in the burrow or at the burrow entrance. We developed a set of criteria for distinguishing burrows of storm-petrels, Ancient Murrelets, Cassin's Auklets and Rhinoceros Auklets (Cerorhinca monocerata): size of entrance; wear at the entrance; droppings in and around the burrow entrance; regurgitated food (for Cassin's Auklet); feathers found in the burrow; eggshell fragments found in the burrow; and odour. No Tufted Puffins (Fratercula cirrhata) were found nesting in association with other species on the east coast of Moresby Island (see Rodway et al. in prep(a)).

Storm-petrels often nest in conjunction with Cassin's Auklets and less often with Ancient Murrelets. Little difficulty is usually encountered differentiating storm-petrel burrows according to size (5-7cm wide). The musty odour of petrels is also helpful. However, we found petrels nesting in old Cassin's Auklet burrows (Skedans Islands), which made identification more complicated. We used odour and the lack of typical Cassin's Auklet signs to help identify petrel burrows in that case.

Ancient Murrelets, Cassin's Auklets and Rhinoceros Auklets are found nesting in the same areas, though the most frequent associations are Ancient Murrelets and Cassin's Auklets, or Cassin's Auklets and Rhinoceros Auklets. Ancient Murrelet and Cassin's Auklet burrows are similar in size (10-12cm wide), while larger burrows (12-15cm wide) generally belong to Rhinoceros Auklets. Droppings, regurgitated food, eggshell fragments, and feathers provide more conclusive evidence for differentiating these three species. Ancient Murrelets and Rhinoceros Auklets have relatively clean burrow entrances. Rhinoceros Auklet burrow entrances are more worn than Ancient Murrelet's. Ancient Murrelet droppings are yellowish-white and are usually placed away from the entrance. The droppings of Rhinoceros Auklets are larger, generally globular, pale yellow with black, viscous blobs, and are often deposited to one side of the burrow entrance. Cassin's Auklets leave white fecal streaking along the approach and into the entrances of their burrows. Cassin's Auklet droppings also have a more arresting odour, as does their regurgitated food, some of which they invariably lose at the entrance to their burrows when delivering it. Abdominal feathers (which are often lost in the burrows) of each species can be distinguished by the colour pattern of their plumules (size is not reliable). Ancient Murrelet plumules are half dark and half white. Cassin's Auklet plumules are mostly dark with a tip of white. The colour of the Rhinoceros Auklet plumule is uniform greyish white and is similar to that of the base of the main feather. Eggshell fragments of Cassin's Auklets and Rhinoceros Auklets are both white and are indistinguishable unless a major portion of the shell is present and can be identified by size. Fragments of Ancient Murrelet eggshell are easily identified by their colour - pale olive background with dark speckling throughout.

6. Predation:

During exploration, notes were kept of all signs of predation or mortality encountered. Areas around Bald Eagle, Peregrine Falcon, and Common Raven nests, and around river otter runs and dens were examined in detail. This gave an indication of the degree and the kind of species being preyed upon. To quantify the level of predation, we calculated the density of prey remains recorded in quadrats, using the minimum possible number of birds represented by the evidence found. We assumed that one feather pile represented one bird. Estimates only allow coarse comparisons between colonies because surveys occurred at various times in the nesting season. It underestimates total predation because plots only sample remains left within the colony before the end of the season. Locations of Bald Eagle nests are indicated on colony maps. Peregrine Falcon eyries are not described for security reasons.

7. Staging:

Near dusk, prior to flying into their nesting slopes, Ancient Murrelets and Rhinoceros Auklets typically aggregate on the water adjacent to their colony (Fig. EM-2). To locate these staging areas, water transects were run in inflatable boats when the weather was calm enough to see birds on the water. Bearings, distance from shore, time, and number of birds sighted were recorded for each water transect. Locations of staging concentrations were determined by proximity and bearings to recognized points of land. If birds were not encountered, the boat was often stopped so that birds might be heard calling from the water. This was only useful for Ancient Murrelets, as we have never heard Rhinoceros Auklets calling on their staging areas.

8. Time:

Times quoted are Pacific Standard Time, adjusted to Daylight Savings Time at 0200hrs on the last Sunday in April of each year (25 April 1982, 24 April 1983, 29 April 1984, 28 April 1985, 27 April 1986) unless otherwise noted. Subtract one hour from Daylight Savings Time to calculate Pacific Standard Time.

Fig. EM-2. Major staging areas of nesting seabirds on the east coast of Moresby Island. (For areas 9 and 10 see Rodway et al. in prep.(a)).

EM-010 KUNGHIT ISLAND 103 B/2,3 102 O/14

Location: At the south end of Moresby Island.

51°57'-52°09'N 130°56'-131°08'W

Land status: Crown Land: part of proposed South Moresby National Park. In 1986, there was a small settlement at Rose Harbour.

Date of visit: 5 June 1985, 1510hrs and 1930hrs (boating by area around Lyman Point) and 5-17 June 1986 (main survey).

Colony access: There were no sheltered landings near colony areas. Crews were dropped off at various points along the shore to explore those sites.

Base camp: We camped on the south side of Heater Harbour (5-9 and 17-18 June), in Woodruff Bay (9-12 June), and on the beach north of Bowles Point (13-16 June). Those sites were spacious with water nearby.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Lemon, M. Rodway, G. Kaiser, D. Powell, D. Garnier, D. Grinnell, H. Hay, N. Holmes.

Census method: Exploration; partial count for Rhinoceros Auklets. In 1985, we boated by the cliffs and steep grassy slopes around Lyman Point and the islet south of it. In 1986, we explored much of the perimeter of the island (Fig. EM010-1). Along most sections of the coast that we did explore, we scouted from the shoreline to as far inland as nesting seemed possible. In areas of cliffs and uniformly steep relief, such as on the north side of Luxana Bay, and on the west side of the south end, we explored along the shore where it was accessible, to 500m inland and 250m in elevation. An exception was on the west side of the island, north of the saddle cutting across from Woodruff Bay, where only the higher slopes were explored. The cliff faces along the west coast were examined from the water. In areas of lower relief, such as around the north end of the island, we explored to the crests of the slopes near shore.

In 1986, time was not available to conduct a more detailed census of the Ancient Murrelet and Rhinoceros Auklet colony areas. Line transects would be an appropriate census method for the Ancient Murrelet colonies, but would be difficult to conduct in the Rhinoceros Auklet colony due to the rugged topography and because nesting occurs in many disjunct patches.

Description: With an area of 12,330ha and a perimeter of 116km, Kunghit is one of the largest islands on the British Columbia coast known to house a major seabird colony. It is a steep-sided island, rising to a maximum elevation of 546m, with deeply cut bays creating a series of projecting peninsulas, especially along the east side. Cliffs are prominent on much of the southern coastline of the island, especially on the east coast from Lyman Point south through the north side of Luxana Bay, and on the west coast from the south tip north to approximately 2km south of Barber Point. The slopes around and above those cliffs are steep, often 50° or more, and in higher areas rise to elevations of 200-300m or more. The topography is more gentle

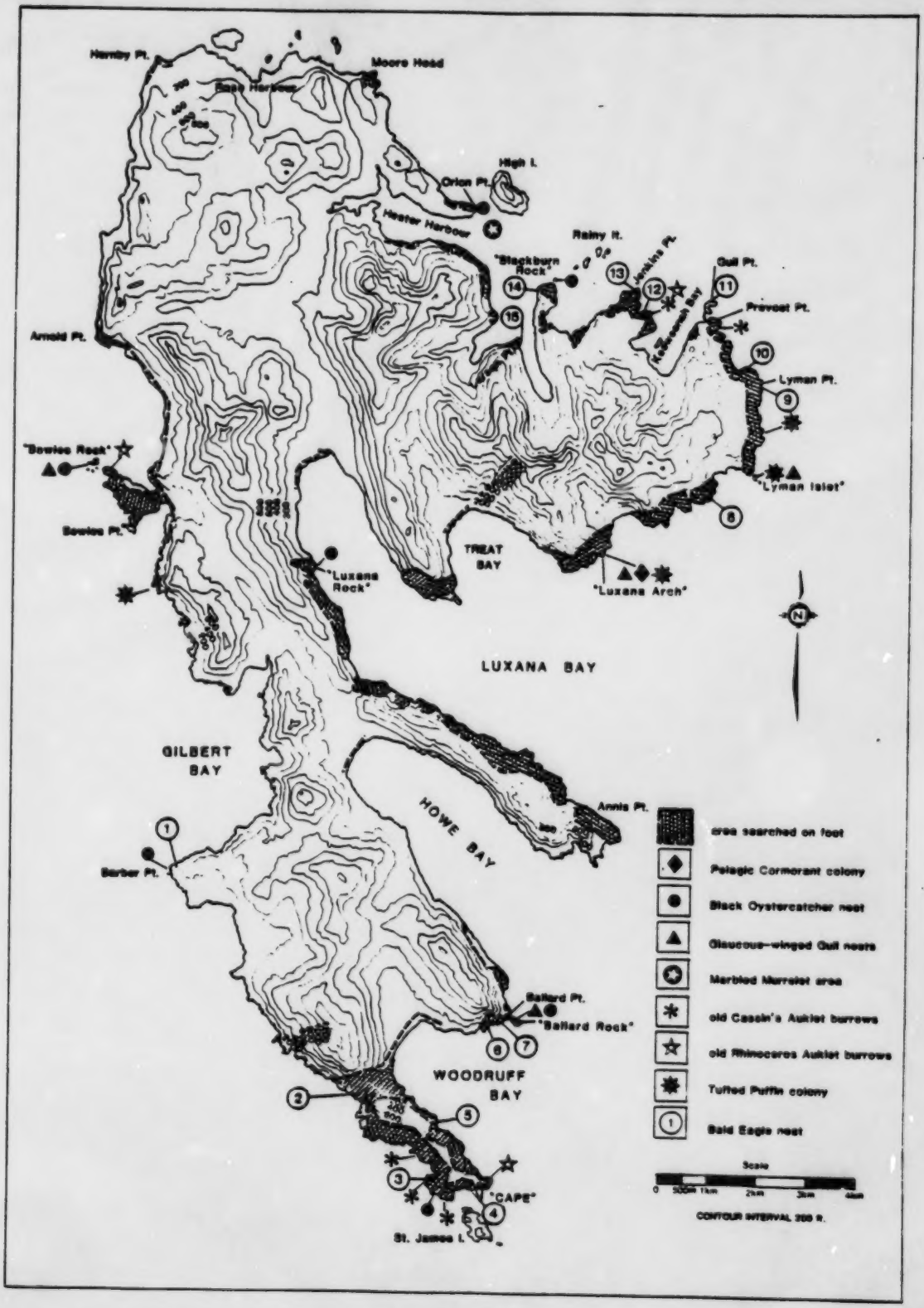

Fig. EM010-1. Area explored and nesting sites on Kunghit Island in 1986. (See also Fig. EM010-2.)

toward the north end of the island, though the shoreline is still rocky and steeply dissected in many areas. Low, level areas occur around Rose Harbour and Hornby Point, as well as in the valleys at the heads of the bays all around the island. There are expansive sandy beaches at the heads of some of these bays, especially in Woodruff and Gilbert Bays.

The island is forested with Sitka Spruce (Picea sitchensis), Western Hemlock (Tsuga heterophylla) and Western Redcedar (Thuja plicata). Spruce is generally more abundant near shore with hemlock and redcedar becoming dominant inland. An area of dwarfed Lodgepole Pine (Pinus contorta) was found above 60m elevation on Blackburn Peninsula and may occur at higher elevations in the interior of other parts of the island. Red Alder (Alnus rubra) and Pacific Crabapple (Malus diversifolia) occur around the shoreline, and Sitka Alder (Alnus sinuata) covers wet slide slopes. The steep slopes around the exposed cliffy areas, and much of the shore edges, are grassy under spruce, changing to moss and bare litter further inland under the thicker hemlock and redcedar canopy. In the steepest areas, these exposed grass slopes extend as high as 150m elevation. Salal (Gaultheria shallon) is abundant in a number of areas that we explored: around Hornby Point and Arnold Point; the south-west facing slopes of the Bowles Point peninsula; the outer rocky knobs around Barber Point; the steep slopes above the cliffs on the point east of Treat Bay (salal on the cliff rims had been heavily browsed by deer in this area); the north facing slopes north of Lyman Point; the east side of Keewanah Bay; the west side of Jenkins Point; the north and south sides of Heater Harbour; and the north side of Orion Point. Salal occurred around more of the northern shore of the island in areas that we did not explore. Regenerating spruce seedlings are scattered over many open grassy slopes, but nowhere did we encounter impenetrable thickets. False azalea (Menziesia ferruginea), huckleberry (Vaccinium spp.), and twinberry (Lonicera involucrata) are sporadic throughout the areas explored.

We have assigned a number of names to nesting sites around the island (Fig. EM010-1):

"Bowles" Rock is the separate rock off the north-west corner of the Bowles Point peninsula. It is mostly bare rock with some grass and Conioselinum pacificum.

"Cape" is the south tip of the island.

"Ballard" Rock is the rock off Ballard Point.

"Luxana" Rock is a 5m high rock on the west side of Luxana Bay.

"Luxana Arch" is a rock arch on the point east of Treat Bay on the north side of Luxana Bay.

"Lyman" Islet is the islet 1.8km south of Lyman Point. This is a steep-sided rock with a cap of grass and a few spruce trees. Salmonberry (Rubus spectabilis) and Maianthemum dilatatum occur on the south and west fringes of the grass.

"Blackburn" Rock is the rock at the north end of Blackburn Peninsula.

Nesting species:

Pelagic Cormorant: Cormorants were nesting on "Luxana Arch" and the cliffs surrounding it. On 7 June at 1800hrs, we counted 22 nests, 6 under the arch and 16 in and above the crevice east of it. A total of 28 breeding adults were present, plus 20 non-breeding adults and 12 immatures. Some adults were flying with nesting material, most were sitting on nests. Nests were not accessible. We saw no other cormorant nest sites around Kunghit Island.

Black Oystercatcher: We recorded the following nests:

Location	Emp	1E	2E	1Y	Total	Adults	
WEST COAST:							
"Bowles" Rock		1	2		3	6	
Barber Point						2	
"Cape" (W side)					1	2	(scared off nest)
EAST COAST:							
"Ballard" Rk.	1				1	2	
"Luxana" Rk.	1				1	2	
"Blackburn" Rk.				1	1	2	
TOTAL	2	1	2	1	7	16	

Nests were made of rock chips and shells.

Glaucous-winged Gull: In 1985, there were 16 adults standing on territory on the rocky portion on the south side of "Lyman" islet. In 1986, we counted the following nests and adults around Kunghit Island:

Location	Empty	1E	2E	3E	Total	Adults
WEST COAST:						
"Bowles" Rock	2	1	2	6	11	46
EAST COAST:						
"Ballard" Rk.	1	1		2	6*	18
"Luxana Arch"					4**	8
"Lyman" Islet					8**	16
TOTAL	3	2	2	8	29**	88

* 2 nests with unknown contents
** estimated

Nests we inspected were made of grass.

In both 1985 and 1986, a small group of gulls regularly bathed and roosted on the sandy estuary in Woodruff Bay. There were 16 adults and 3 immatures on 9 June 1986.

Pigeon Guillemot: We counted the following birds at various times around the island:

Location		Adults	Date and time
WEST COAST:			
	"Bowles" Rock	4	16 June, 1600hrs
	Bowles Point	15	13 June, 1100hrs
	Barber Point	15	13 June, 1040hrs
EAST COAST:			
	Ballard Point	4	12 June
	Annis Point	8	12 June, 1100hrs
	E of Treat Bay	2	6 June, 1400hrs
	Lyman Pt. & S	107	5 June, 1100hrs
	TOTAL	155	

We also saw 25 at the mouth of Treat Bay on 7 June at 1130hrs, and 60 offshore from the cape to Gilbert Bay on 10 June at 1400hrs. Those birds may have nested around the island, but they were not associated with any nest sites. From those we saw on or near nesting habitat on shore, we estimated a nesting population of 100 pairs.

We also repeatedly observed 1 immature in winter plumage north of Gull Point in 1986.

Marbled Murrelet: Marbled Murrelets (Brachyramphus marmoratus) were likely nesting on Kunghit Island. Groups of up to 80 adults were regularly gathered at the mouth of Heater Harbour, and individuals were repeatedly heard calling and flying over our camp on the south shore in the evening (2230hrs) and early morning (0400hrs). Scattered pairs were seen along the west side of the island.

Ancient Murrelet: We found two nesting areas of Ancient Murrelets, one around Jenkins Point and one on the south side of Luxana Bay, west of Annis Point (Fig. EM010-2). At Jenkins Point, burrowing was sparse but continuous on the slopes on the north side of the point. Most burrows were located under roots in a hemlock and spruce forest with a bare litter floor. Burrowing extended from near shore to the ridge crest at about 70m elevation. There were scattered burrows for a short distance on the east side of the point. To the west, the habitat was cut by deep grassy gorges. The highest density of burrows occurred on the ridges between these gorges. Burrowing extended up slope, and to the west until the vegetation changed to thick salal where the burrowing ended. The overall area of burrowing was 8.9ha. We estimated the nesting population in this area to be 800 pairs.

The colony on the south side of Luxana Bay covered a larger area and had a higher density of nesting than at Jenkins Point. Most burrows here were also under roots on open mossy or bare litter slopes under a hemlock and spruce forest, although some burrows were located on steep grassy slopes as well. Burrowing extended from sea-level to 100-130m, and along the shore for a distance of 1500m. The area of burrowing here was 35.3ha. We estimated 8000 pairs were nesting here.

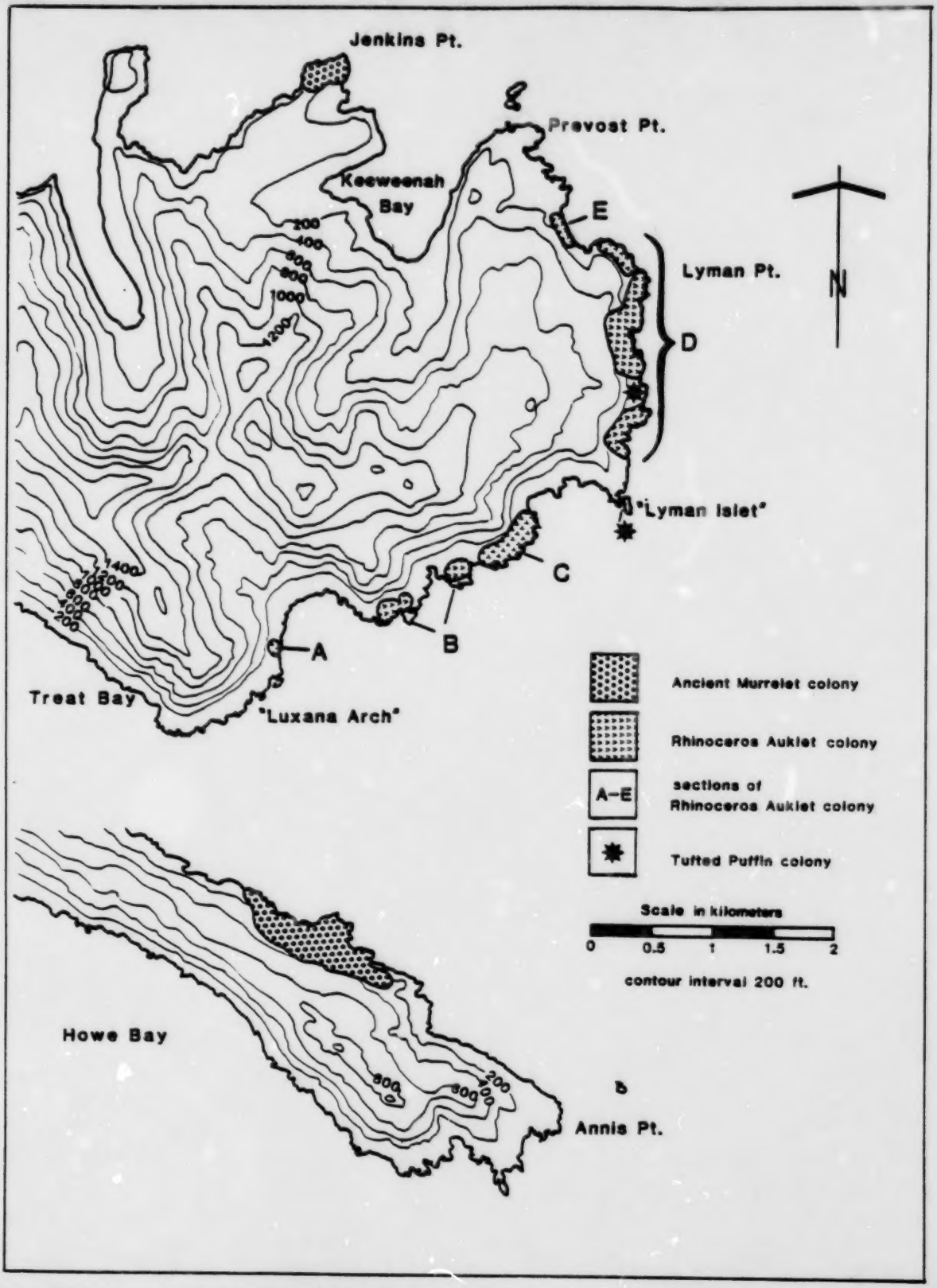

Fig. EM010-2. Ancient Murrelet and Rhinoceros Auklet colony areas on Kunghit Island in 1986.

Much of the breeding population would have already left the colonies at the time of our survey, but burrows still appeared well worn with lots of droppings and feathers about. Hatched eggshell membranes were pulled from burrows on Jenkins Point, and a chick was observed on the water off the Luxana Bay colony at 1100hrs on 12 June.

Combining the estimates for the two colony areas, our estimate for the total population of Ancient Murrelets nesting on Kunghit Island in 1986 is 8,800 pairs.

Maximum numbers of Ancient Murrelets observed was 120, in flocks of 10-20, flying west into Luxana Bay on 5 June 1985 at 1915hrs.

Cassin's Auklet: The only active-looking Cassin's Auklet burrows we found were located in lower edges of the grassy slopes and on raised knobs around Lyman Point. They were mixed with Rhinoceros Auklet burrows which outnumbered them 20:1. We estimated 50 pairs of Cassin's Auklets nesting in that area.

We found a few old Cassin's Auklet sized burrows at four other sites: on the south-west corner of the south tip of the island (14); on the west side just north of the south tip (3); on the point east of Jenkins Point (4), and at Prevost Point (3). Old feathers were found in those burrows.

We saw a flock of 10 Cassin's Auklets at the mouth of Luxana Bay at 1915hrs on 5 June 1985.

Rhinoceros Auklet: We found one extensive Rhinoceros Auklet colony which stretched from the bay east of Treat Bay around to the bay north of Lyman Point. Burrowing occurred in many disjunct patches through that area (Fig. EM010-2). The most continuous section of burrowing was south of Lyman Point. Burrows were located under grass, roots, stumps and logs on steep grassy slopes, bare litter slopes and on raised knolls near shore. Patches occurred above cliffs and below cliffs, extending from near shore to as high as 110m, though more commonly between 10 and 60m elevation. We estimated the total area of burrowing to be 43ha. The numbers of burrows in various areas were counted or estimated as follows (Fig. EM010-2):

A.	On the west side of the bay east of Treat Bay	- 3
B.	From bay east of Treat Bay to small bay east	- 96
C.	From small bay above to bay west of "Lyman" Islet	- 1200
D.	From small notch bay north of "Lyman" Islet to bay north of Lyman Point	- 1642
E.	On west side of bay north of Lyman Point	- 255
	TOTAL	- 3196

We would round the total number of burrows to 3200.

Burrows in this colony were well worn with lots of droppings and feathers near the entrances. Few burrows were excavated; one contained an incubating adult. We estimated the 1986 nesting population to be 2500 pairs.

We saw no sign of Rhinoceros Auklets nesting anywhere else on Kunghit Island. A few possible old burrows were found in the bay north of the cape on the west side (2), on the south-east corner of the cape (4), and on the point east of Jenkins Point (1). Some of these contained old feathers.

Maximum numbers of Rhinoceros Auklets observed around Kunghit Island was 115 (1 immature) in a feeding ball at the mouth of Keeweenah Bay at 1100hrs on 7 June.

Tufted Puffin: In 1985, a total of 41 were seen in the vicinity of Lyman Point and the islet south of it. We saw six fly off the grassy ledges on the cliffs at Lyman Point and six fly off the grassy slope of the islet.

In 1986, puffins were nesting at three locations around Kunghit Island (Fig. EM010-1):

On the point south of Bowles Point - 3 adults were present on 17 June at 2000hrs.; one flew out of a grassy ledge on the rock bluffs. Keith Moore (pers comm) also reported 1 adult flying off the cliffs here on 4 June.

At "Luxana Arch" - 2 were present on 7 June at 1445hrs. Keith Moore (pers comm) also reported 1 adult flying off the cliff at this site on 5 June.

On "Lyman" Islet and the cliffs north of it, south of Lyman Point. The maximum numbers counted in this area were 128 sitting out on the islet and 110 in the water surrounding it, plus 80 on the cliffs and water north of the islet (Fig. EM-2), giving a total of 318. These were counted on 5 June at 1100hrs. Puffins were nesting on the grassy slopes on the islet and on grassy ledges on the cliffs to the north. Lyman Islet is the only accessible nesting area where burrows may be counted. To avoid disturbing the birds, we did not land. It should be surveyed later in the season when disturbance would be less likely to cause desertion.

We suspected a nesting population in the range of 200-300 pairs though we have used total number of birds seen (323) to indicate the size of the colony on Kunghit Island in 1986 (Table EM-1 p. 250).

In 1986, we observed puffins feeding south of Woodruff Bay, east of the south tip of the island (300 on 12 June), at the mouth of Luxana Bay (41, including 1 first year bird, at 1700hrs on 8 June), and at the mouth of Keeweenah Bay (24 at 1000hrs on 7 June).

Predation: We observed signs of predation mainly in the Ancient Murrelet colonies. In the colony on Jenkins Point we recorded 17 feather piles, 4 single wings, 1 pair of attached wings, and 9 eggshells of Ancient Murrelets. In the Luxana Bay colony we noted 11 feather piles, 2 pairs of attached wings, 1 single wing, 2 eaten carcasses, 1 pile of chick down, and 7 eggshells of Ancient Murrelets. In that area, there were also 2 Cassin's Auklet carcasses and single feather piles of Sooty Shearwater, Fork-tailed Storm-Petrel, Black-

legged Kittiwake and Herring Gull. We saw little evidence of predation on Rhinoceros Auklets (1 pair of attached wings and 1 single wing).

Associated species: Sightings from 1986 unless otherwise noted.

Pelagic Cormorant - 5 adults and 11 immatures in Woodruff Bay on 11 June.

Bald Eagle - 15 nests were recorded (Fig. EM010-1):

1. Barber Point - 200m north-east of tip.

2. West side Kunghit, directly west of the head of Woodruff Bay - 18m high in 25m tree at 70m elevation, 50m from edge of rock bluff. No adults on 11 June.

3. West side at south-west corner of bay north of south tip - 15m high in 25m tree at 100m elevation on nose of ridge. No adults at 1200hrs on 11 June.

4. East point of south tip - cluster of 3 nests: 2 were 15m high in 25m spruce, and one old one was at top of 30m spruce. Trees were within 100m of each other and within 20m of shore. Two adults were present and excited on 10 June at 1730hrs.

5. East side Kunghit, south of Woodruff Bay - near top of 30m spruce. No adults on 11 June.

6. Ballard Point, on the west side of a small bay to the west - in a tree on a bluff; new nest above an old one. Two adults attending 11 June.

7. Headland west of Ballard Point - old nest with 30cm spruce seedling in the middle.

8. Point west of "Lyman" islet - top of 25m snag at 150m elevation. 2 adults excited on 6 June.

9. Lyman Point - 30m high in 35m spruce on edge of gorge on south side of point. One adult present in 1985; 1 adult sitting on nest and 1 nearby on 5 June 1986.

10. Point north of Lyman Point on the east side of the bay - 22m high in 30m spruce, 5m from shore rock. Two adults present in 1985; one adult sitting on nest at 1000hrs on 6 June 1986.

11. Gull Point - 20m high in 35m snag, 30m from shore.

12. East side of Jenkins Point - 25m high in 30m forked spruce, 10m from shore. Grass and salal growing on rim. No adults on 5 June.

13. Jenkins Point - two nests 20m apart: one 18m high in 20m spruce on grassy point, and one 25m high in 30m spruce, 20m up grassy slope. In 1985, there was one adult present at each tree. No adults were recorded in 1986.

14. Blackburn Point - 200m from point.

15. Larsen Point - no adults present 5 June.

Red-tailed Hawk - 1 on south side of Howe Bay on 12 June.

Peregrine Falcon - observed at 5 sites:

1. West side just north of south tip - 2 empty eyries observed. 1 pair on 11 June.

2. North side of Annis Point, about 2km north-west of point. 2 adult and one recently fledged young on 12 June.

3. South of Lyman Point in gorge. 1 adult on 5 June.

4. Point east of Jenkins Point. 1 adult on 5 June.

5. Ballard Point. 1 pair chasing Bald Eagle from islet on 11 June.

Northwestern Crow

Common Raven - nest suspected south of Lyman Point.

Hair Seal - 15 (2 pups) on rocks on east side of Prevost Point on 6 June. 13 (5 pups) on reefs at Annis Point on 12 June.

River Otter

Sitka Deer

Racoon - report of a single animal by residents at Rose Harbour.

EM-020 MARSHALL ISLAND 103 B/2

Location: In Keeweenah Bay on the north-east side of Kunghit Island.

$52^{0}05'55''N$ $130^{0}58'W$

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 6 June 1986 (1030-1100hrs).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway, D. Garnier, H. Hay, N. Holmes.

Census method: Exploration.

Description: Marshall is a cigar shaped, 1.2ha island with rocky shores, rising to about 10m. It is almost completely covered with thick salal under a spruce, cedar, and hemlock forest. Crabapple grows along the shore. There are small fringes of grass and moss on the perimeter.

Nesting species:

Black Oystercatcher: 5 adults were present, One pair on the north end was excited, but no nest was found.

Pigeon Guillemot: 27 adults were on the water around the island. We found 17 burrows on the edge of the vegetation. One adult flew out of one burrow. No contents were determined.

Associated species:

Bald Eagle - 1 nest in center of the island: 7m high in 16m spruce. No adults present.

Northwestern Crow - 6

River Otter - runways and scats.

EH-030 GULL ISLET 103 B/2

Location: On the east side of Kunghit Island off Prevost Point.

52°06'30"N 130°57'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 5 June 1985 (1500hrs) and 18 June 1986 (1155-1215hrs).

Colony access: Drop-off from boat.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: D. Grinnell, M. Rodway.

Census method: In 1985, we only boated by the islet. We explored it in 1986.

Description: Gull Islet is an extensive (1.7ha), dissected, low rock, with an area of grass and stunted spruce on the southern portion.

Nesting species:

Black Oystercatcher: In 1986, we found 1 empty nest, and 1 nest with 2 eggs. Nests were made of rock chips. 4 adults were present.

Glaucous-winged Gull: In 1985, we saw 2 adults standing on territory. There were 2 adults present in 1986 as well. No nest was found, but we may have missed it as the area is extensive.

Pigeon Guillemot: In 1986, there were 8 adults on the rock and in the water. 1 flew from a crevice.

EM-040 RAINY ISLANDS 103 B/2

Location: North of Montserrat Bay on north-east coast of Kunghit Island.

52°07'N 130°59'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 5 June 1985, 1500hrs (northeast gull rock); and 5 June 1986, 1400-1530hrs (larger islands), 18 June 1986, 1150-1230hrs (gull rocks).

Colony access: Drop-off from boat.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power.

1986: D. Garnier, M. Rodway.

Census method: In 1985, we only boated past the outer islands. Partial count for storm-petrels, total count for surface nesters in 1986.

Description: The islands are steep-sided, deeply dissected rocks. Their total area is 4.4ha. The two larger islands are predominantly forested with spruce. Much of the understory is salal, with areas of moss and mossy deadfall occurring in the interior. There are grassy slopes on the north-west side, and dense regenerating spruce on the south-east and top of the northern island. The two smaller east islands are mainly bare rock.

Nesting species:

Storm-Petrel: A few storm-petrel burrows were found scattered in mossy areas and where the salal was thin (Fig. EM040-1). No contents were determined. Two Fork-tailed Storm-Petrel feather piles and 1 skull were found. We estimated 100 pairs of storm-petrels nesting.

Black Oystercatcher: 6 adults present in 1986: 1 hatched eggshell found near one pair on the larger north island; 1 empty nest on the south-east rock, and 1 nest with 2 eggs on the north-east rock. Nests made of rock chips, limpet and mussel shells.

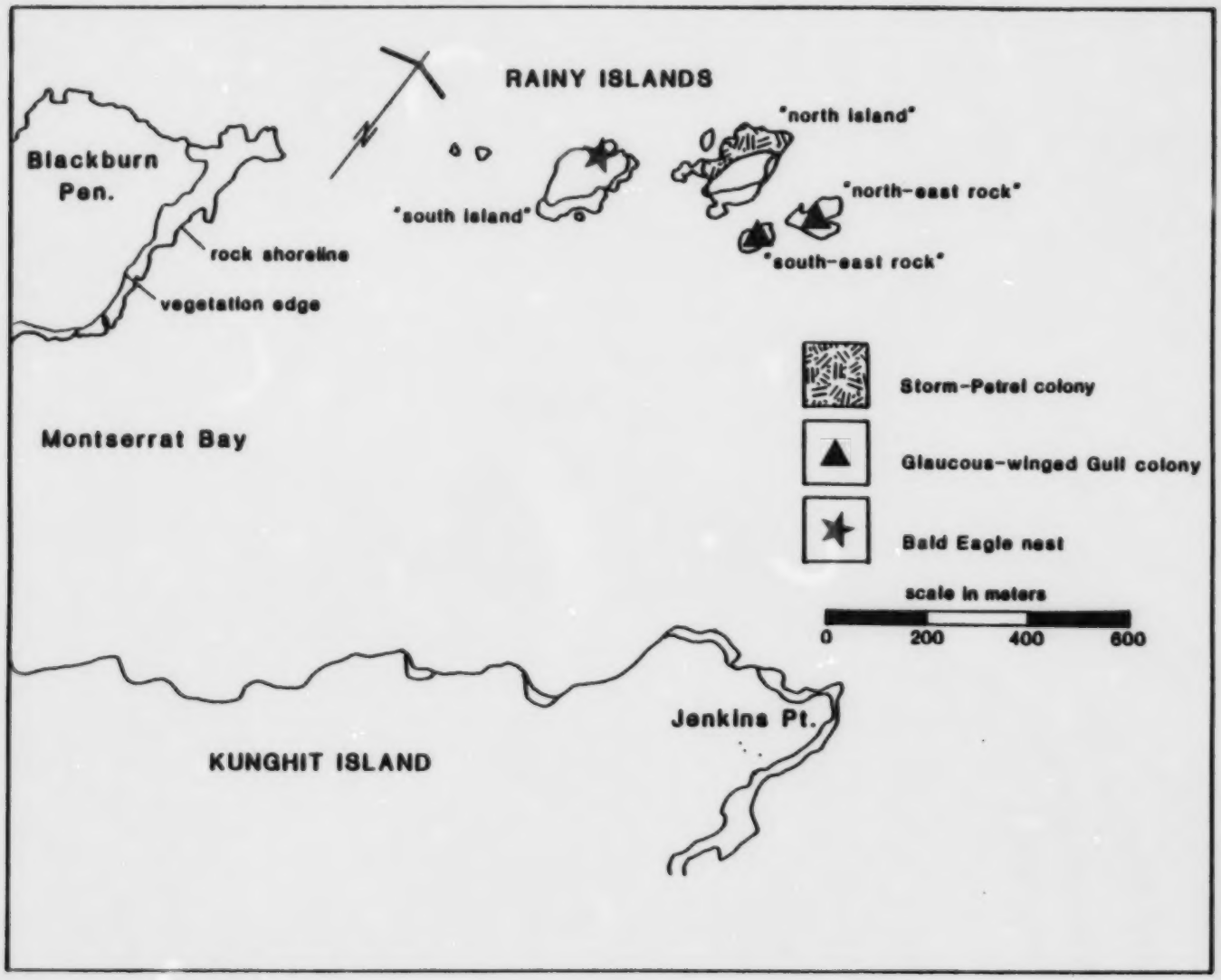

Figure EM040-1. Storm-Petrel colony area on Rainy Islands in 1986.

Glaucous-winged Gull: In 1985, 48 adults were standing on territory on the outer north-east rock. In 1986, we counted the following numbers of nests on the east rocks:

	Start	empty	1E	2E	3E	Total
NE rock	1	1	2	2	12	18
SE rock		1			7	8
TOTAL	1	2	2	2	19	26

Pigeon Guillemot: In 1986, 6 birds were flushed from inaccessible nests on the larger islands; 14 were on the rocks and water around the east rocks.

Cassin's Auklet, Rhinoceros Auklet: 7 old large burrows and a few smaller burrows were seen scattered around trees. No evidence of present use was found.

Associated species:

Pelagic Cormorant - 4 immature

Bald Eagle - nest 15m high in 16m snag at the NW corner of the southern forested island. 5 pellets of feathers and a Northern Fulmar skull were found.

Northwestern Crow

EM-050 HIGH ISLAND 103 B/3

Location: Off north-east side of Kunghit Island. 52°07'40"N 131°00'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 5 June (2015hrs) to 6 June (1900hrs), 1985.

Colony access: Boat landing on beach on west side.

Base camp: We camped above beach on west side. No water was available.

Observers: M. Lemon, M. Rodway, D. Garnier, D. Power.

Census method: Exploration.

Description: This is a very steep 42ha island rising to 177m with many cliffs both along the shore and recessed in the interior. Most of the shore is steep and rocky, except for the gravel beach on the west side. It is forested with large spruce, hemlock and redcedar. Most of the understory is bare or mossy. The north-east side has steep, grassy slopes and fringes of grass occur around the island. There are patches of windfall and young spruce (1-3m high) regeneration occurs in open areas. Salal, huckleberry, elderberry

(Sambucus racemosa) and salmonberry are found near shore and on the edges of cliffs. Some Sitka Alder grows on wetter slopes and crabapple is scattered along the shore.

Nesting species:

Pigeon Guillemot: 8 birds were seen around the island. One flew off the rocks at the north end.

Rhinoceros Auklet: 4 well worn burrows and 2 old burrows were found under tree roots on a shore knoll just west of the south point. We found 1 feather pile and bill at the north-west corner. We suspected there were no more than 10 burrows on the island. No positive evidence of nesting was obtained. 120 birds were counted at 1300hrs in a feeding ball between High Island and Germania rock.

Ancient Murrelet: 1 possible burrow was found on the south point. There was no evidence of nesting.

Associated species:

Black Oystercatcher - Only flying by.

Northwestern Crow

Common Raven

Hair Seal

River Otter

Sitka Deer

EM-060 HAYDON ROCK 103 B/3

Location: North-west of High Island. 52°06'40"N 131°02'05"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 18 June 1986 (1240-1250hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census Method: Total count.

Description: Bare rock.

Nesting species:

Black Oystercatcher: 1 nest with 2 eggs. Nest was made of rock chips and shells. 2 adults.

Glaucous-winged Gull: 1 nest with 1 egg. Nest was made of bark, woody stalks of Rumex, and grass. 2 adults.

EM-070 CHARLES ISLANDS 103 B/3

Location: East entrance to Houston Stewart Channel. 52°09'20"N 131°03'40"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 6 June 1985 (1630-1700hrs), and 6 June 1986.

Colony access: Boat landing on west side of beach between two island sections.

Observers: 1985: D. Garnier, D. Power, M. Lemon. 1986: D. Powell, D. Grinnell.

Census method: Exploration and partial count.

Description: These two rocky islands total 2.6ha and are connected by a gravel beach. They are covered with thick salal under a forest of spruce mixed with hemlock and crabapple. Mossy and grassy patches occur on the fringes.

Nesting species:

Storm-Petrel: Burrows were scattered through the salal and along the edges. In 1985, 24 petrel burrows were counted on the north island on the edge of the salal and in the small grassy patches. In 1986, 50 burrows were found on the north island, and 33 were counted around the south island. No contents were determined, but depredated remains of Fork-tailed Storm-Petrels were found (see below). No signs of Leach's Storm-Petrels were encountered at the time of these surveys, but they may nest here since they breed later. We estimated the nesting population of storm-petrels to be 100 pairs.

Black Oystercatcher: 1 pair on the south island. 1 empty scape was found in 1985.

Pigeon Guillemot: In 1985, 24 birds were on the rock and in the water on the west side. One bird flew from a crevice on the south island in 1986.

Cassin's Auklet: In 1985, observers counted 12 burrows around the edge of the south island. No contents were determined. We estimated 10 pairs nesting. Burrows were distinguished from Rhinoceros Auklet by size, droppings and feathers. No burrows were reported in 1986.

Rhinoceros Auklet: Burrows were mostly found on the edge under roots and deadfall in mossy areas, but some occurred into the middle of the islands scattered through open areas in the salal. Most had droppings and feathers at

the entrance. In 1985, a total of 67 burrows were counted: 57 around the west side of the north island, and 10 around the south island. We estimated 50 pairs nesting. In 1986, 131 burrows were counted around the north island, and 40 around the south island. We estimated the 1986 nesting population to be 130 pairs.

Predation:

Considerable evidence of predation was recorded in 1986: 32 feather piles and 4 pairs of wings of Fork-tailed Storm-Petrels; and 7 feather piles and 2 wings of Rhinoceros Auklets. Some feathers were found on river otter runs, though most of the river otter scats contained only fish. Five petrel and 1 Rhinoceros Auklet burrows had been dug up. One petrel burrow contained a broken eggshell.

Associated species:

Bald Eagle - 1 adult

Northwestern Crow - 3

Hair Seal - 1

River Otter - There were 2 runs on the east side of the north island.

KM-080 ANNETTE ISLAND 103 B/3

(including smaller, unnamed islet south-west of Annette I.)

Location: Houston Stewart Channel, north-east of Rose Harbour.

52°09'24"N 131°04'22"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 6 June 1985 (1700-1715hrs), and 6 June 1986.

Colony access: Drop-off from boat.

Observers: 1985: D. Power, D. Garnier, M. Lemon; 1986: D. Grinnell.

Census method: In 1985, we only boated around the island. Exploration and total count in 1986.

Description: Annette is a 1.3ha island, covered with salal under a spruce forest, with some mossy fringes on the rocky shores. The habitat on the smaller south-west islet is similar.

Nesting species:

Storm-Petrel: In 1986, 10 unused burrows were found on the south end of the smaller south-west islet.

Pigeon Guillemot: In 1985, 15 were sitting on the rocks at the north end of Annette Island and 1 flew out of the edge of the vegetation. 6 streaked burrows were found under the salal and on the mossy edge. In 1986, 9 adults were present in this same area.

Rhinoceros Auklet: In 1986, a total of 65 burrows were counted along the edge of the vegetation on the north-west corner and north-east side of Annette Island. Of these, 21 appeared active, with droppings, feathers, and worn entrances. On the smaller south-west islet, 8 unused burrows were found on the north-east corner. We suspected 20 pairs nesting.

Associated species:

Bald Eagle - 1 nest on the center, east side of the SW islet: 15m high in 25m spruce.

Northwestern Crow - 1 empty nest at the base of the tree with the eagle nest.

EM-090 GARCIN ROCKS 103 B/2

Location: East of Benjamin Point. 52°12'30"N 130°57'55"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 18 June 1986 1537-1638hrs.

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This 0.6ha islet is mostly bare rock with patches of grass and forbs, and a pocket of sedges in the low, middle top. *Rumex sp.* and *Oenanthe sarmentosa* are common. There is a light beacon on the north-east section. Scattered old batteries and wood, as well as two old light stands litter the area.

Nesting species:

Glaucous-winged Gull: We counted the following nests:

	Start	Emp	1E	2E	3E	4E	Total
W section	2	3	4	5	31		45
NE section			3	3	22		28
SE rock		4	1	4	19	1	29
TOTAL	2	7	8	12	72	1	102

Nests were built of Rumex, Cochlearia officinalis, Oenanthe, grass and Fucus sp..

Pigeon Guillemot:

1E	2E	Total
2	1	3

Nests under rocks and in crevices. 6 adults around rocks.

Associated species:

Pelagic Cormorant - 29 non-breeding birds roosting.

Glaucous-winged Gull - 30 immatures

Hair Seal - 19

EM-100 LANGTRY ISLAND 103 B/3

Location: East of Ingraham Point at southeast corner of Carpenter Bay.

52°13'55"N 131°00'20"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 6 June (1830-1900hrs) and 7 June (1400-1700hrs) 1985.

Colony access: Drop-off from boat.

Sensitivity: Fragile Storm-Petrel colony and lush herbaceous vegetation would be damaged by human traffic.

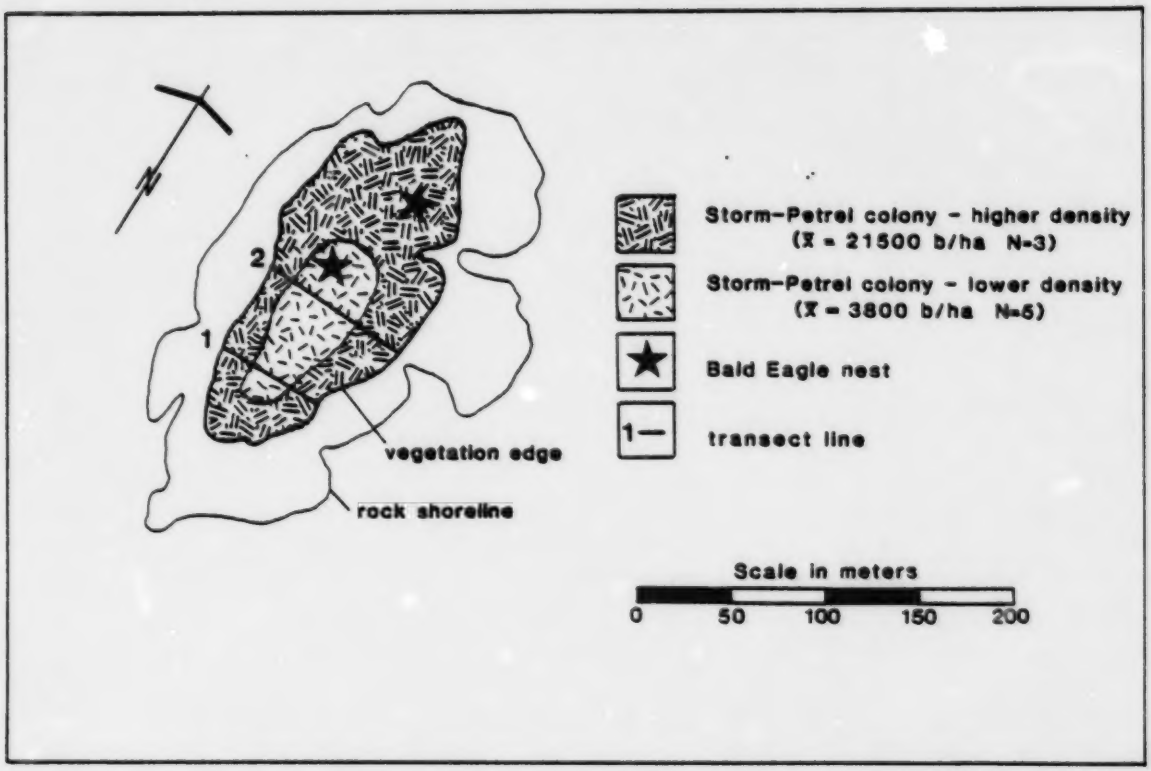

Fig. EM100-1. Storm-Petrel colony area and transect locations on Langtry Island in 1985.

Observers: M. Lemon, M. Rodway.

Census method: Line transects: 8 quadrats (3mx3m) spaced 15m apart along 2 transects 50m apart, run on a bearing of 270° (Fig. EM100-1).

Description: Langtry is a 3.4ha, oval shaped island with rock shelfs and bluffs around the perimeter. Slopes rise to a maximum elevation of 50m on a north-south running ridge crest that is cut by a steep-sided gully towards the north end. There is 1.3ha of vegetated area. Lush grass and forbs under large spruce trees cover the gully and the northern knoll, as well as a 10-15m band around the perimeter of the larger southern section.

Salmonberry, twinberry and currant (Ribes sp.) occur on the west side of the south ridge. The interior of the southern portion is forested with a dense young stand of spruce (20cm dbh), precluding any understory vegetation. The ground here has a soft, thick carpet of needle and twig litter.

Nesting species:

Fork-tailed Storm-Petrel: We found petrel burrows throughout the vegetated area of the island under grass and forbs, logs, tree bases, roots, and into the bare litter forest floor. Burrows were most concentrated at the transition zone between the grassy edges and the bare interior. We did not pull any birds from burrows but we heard both petrel species calling from burrows. The following calculations include all petrel burrows found in sample plots (Table EM100-1).

Table EM100-1. Number of Storm-Petrel burrows in 3mx3m plots along transects on Langtry Island in 1985. Numbers in bold print indicate plots within designated higher density area.

Transect	Plot 1	2	3	4	5
1	**19**	1	3		
2	**23**	2	9	2	**16**

Number of sample plots:	Higher density:	3
	Lower density:	5
	Overall:	8 (72 m^2 - 0.6% of colony area)
Average density:	Higher density:	21500 ± 2300 burrows/ha
	Lower density:	3800 ± 1600 burrows/ha
	Overall:	10,413 ± 3464 burrows/ha
Colony area:	1.3 ha	
Total burrows:	13,537 ± 4503	

Occupancy rate: Rate was not determined as we were too early in the season for Leach's Storm-Petrels.

1985 Nesting population: Using the median occupancy rate for British Columbia of 91%, we estimated 12,319 ± 4098 pairs of both species nesting. There was a number of depredated remains of both species (see below).

Leach's Storm-Petrel: See Fork-tailed Storm-Petrel.

Black Oystercatcher: We found three nests: 1 with 2 eggs, and 2 with 3 eggs. The first was on the west side on a high gravel beach; the nest was made of rock chips and shell. The other two were on the southwest tip and the southeast corner and were made of rock chips laid on bare rock. One had some shell fragments as well.

Pigeon Guillemot: We saw a maximum of 7 birds. One flew out of a burrow at the edge of the vegetation. We found 2 streaked burrows just above the rock on the west side.

We found no sign of nesting by other alcids.

Predation: We observed depredated remains of Fork-tailed Storm-Petrel (11 wings), Leach's Storm-Petrel (15 single wings and 1 pair of attached wings), and Sooty Shearwater (1 wing). We also saw 2 burrows that appeared to have been dug up, possibly by river otter.

Associated species:

Glaucous-winged Gull - 2

Bald Eagle - 1 pair; 2 nests: The active nest was 20m high in a 35m spruce, 30m from shore on the south edge of the main gully. 2 adults were present. The second nest was on the north knoll, 20m high in a 25m spruce, 5m from the edge of the vegetation.

Northwestern Crow - 12; fledged young were seen.

Hair Seal - 3

River Otter - Well used den in the center of the island. We found some scats with feathers in them.

Location: North of the mouth of Carpenter Bay. 52°15'30"N 131°03'W.

Land status: Provincial Ecological Reserve; Part of proposed South Moresby National Park.

Date of visit: 29 May to 8 June 1984 (exploration, transects and permanent plots on west island), 8 June 1985 (exploration and transects on east island), 18 June 1986 (occupancy plot for storm-petrels on the east island and total count of gull colony).

Colony access: Boat landings can be made on the east side bays of the west Rankine Island. The beach in the northern of these two east bays is only accessible near high tide. The bays are exposed to east winds. The east island requires drop-offs from the boat except in calm weather when the tidal rock shelf on the east side is a possible landing site.

Base camp: There is minimal camping space, without water, in the north-east bay on the west island. There is a good camp site with water in the bay on Moresby Island directly west of Rankine Islands.

Sensitivity: The east island is a fragile storm-petrel colony, with lush areas of herbaceous vegetation, susceptible to damage from human traffic. Minimal signs of deer observed on the east island suggest that deer may have only recently reached this island. Increased deer use could also damage the fragile storm-petrel habitat. On the west island, areas of high burrow density, especially near shore along the east side, are also easily damaged.

Observers: 1984: M. Lemon, M. Rodway, D. Bertram, D. Powell, M. Biro, C. Robichaud. 1985: M. Lemon, M. Rodway. 1986: M. Rodway, D.Garnier, D. Grinnell.

Census methods: On the west island, six parallel transects, oriented east-west, were run at 150m intervals across the island (Fig. EM120-1, Table EM120-1). 109 quadrats (5mx5m) were surveyed at 30m intervals along the transects. On the east island, 12 quadrats (3mx3m) were surveyed at 15m intervals along 2 transects 70m apart run at the same bearing of 270° across the island. Transect 1 totalled 78m in length, and transect 2 was 81m.

Table EM120-1. Transect parameters on west Rankine Island in 1984.

Transect	Bearing (°)	Total length (m)	Elevation (m) Beg.	End	Max.	Average slope (°)	Range of slope (°)
1	270	257	5	3	20	19	3-33
2	270	345	3	6	12	8	0-30
3	90	709	3	3	40	10	0-30
4	270	823	2	2	30	11	0-30
5	90	622	12	14	31	5	0-22
6	90	425	2	4	18	7	0-30

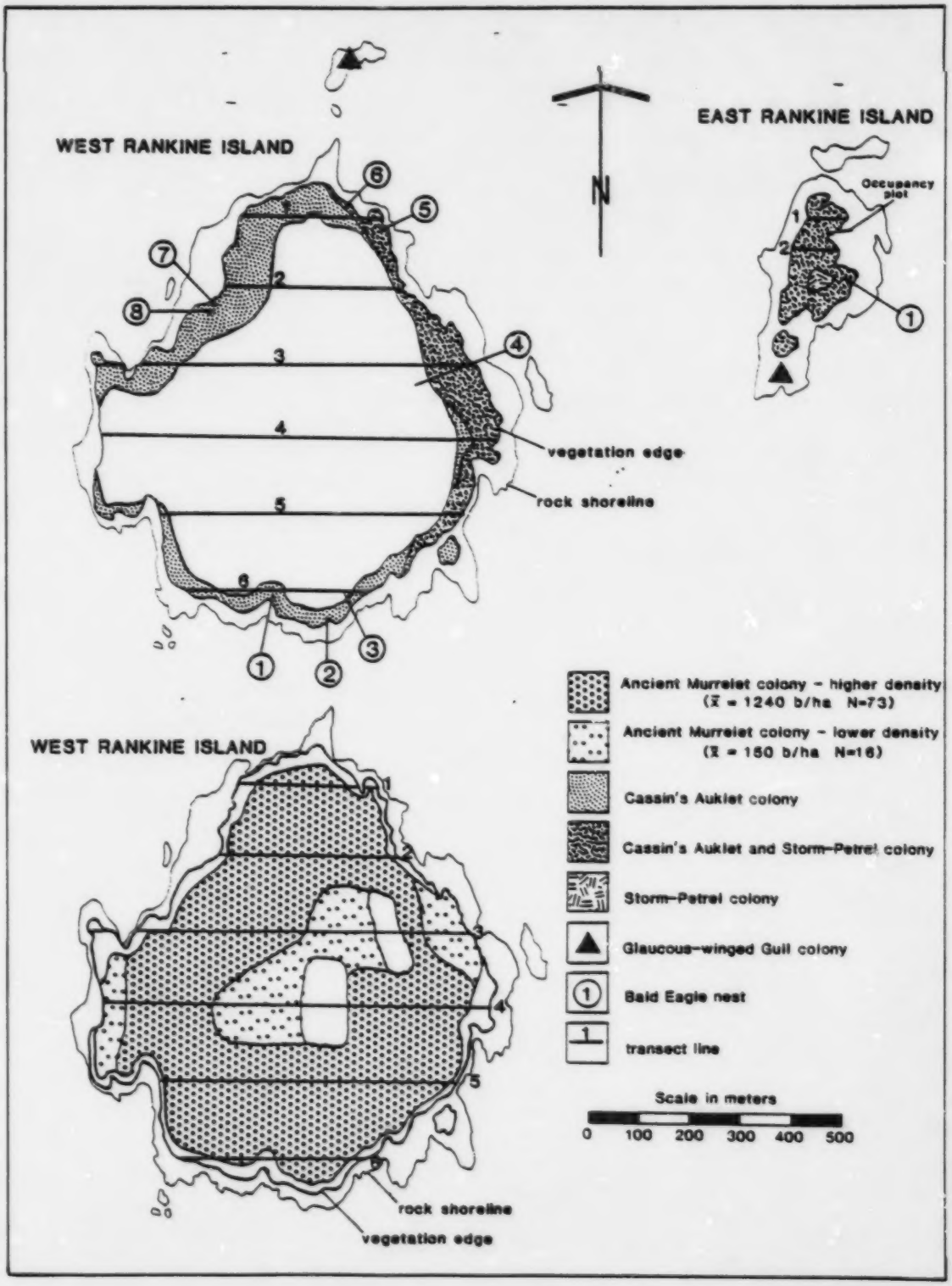

Fig. EM120-1. Seabird colony areas and transect locations on Rankine Islands in 1984 and 1985.

Permanent Plots were established for Ancient Murrelets and Cassin's Auklets (Appendix II).

In 1984 we also banded and measured adults and chicks (Appendix III), and set up an experimental trapping plot (Appendix IV).

In 1986, we made a total count of nesting gulls.

Description: Rankine Islands consist of two islands with a total area of 63.1ha. We describe each island and its nesting seabirds separately, with a summary of nesting populations following the two accounts.

WEST ISLAND

Description: The west Rankine Island, with an area of 55.7ha, has a circular shape indented by a few small bays. It has a rocky shoreline except for small beaches at the head of the bays. The bays, as well as the ridges that run through the island, tend in a north-south direction. Most of the slopes on these ridges are moderate, with some steeper slopes occurring on the northwest side where they rise to the maximum elevation on the island of 40m as determined on our survey. Wet, low-lying areas occur between the ridges in the interior of the island.

Most of the 46.6ha of vegetated area is forested with spruce, cedar, and hemlock. Spruce predominates near shore, while redcedar and hemlock are more frequent in the interior. There is a stand of very large redcedar (up to 3.0m dbh) in the southwest interior. The forest floor is mostly mossy, with fringes of grass occurring along the shore at the north end, and in windfall areas. There is an extensive sphagnum bog in a low-lying valley between two ridges towards the east side. Windfalls have occurred in the past on the northwest corner, the outer west side, and on the southeast corner. Young spruce are regenerating in the southeast and outer west areas, while well established second growth hemlock and redcedar are growing in the northwest area.

Nesting species:

Storm-Petrel: Petrels were burrowing on the east side of the island in level, mossy or bare litter areas under roots, logs, and in open ground (Fig. EM120-1 and Table EM120-2). Burrowing occurred along 700m of the east shore and extended as far as 85m inland (Table EM120-3).

Number of sample plots:	9 (225m^2 - 0.6% of colony)
Average Density:	666 $\pm$ 200 burrows/ha (Table EM120-4)
Colony Area:	3.9 ha
Total Burrows:	2597 $\pm$ 780

1984 Occupancy Rate: No occupancy rate was determined in 1984 for petrel burrows as our survey occurred too early in the breeding season for Leach's Storm-Petrels. We heard many birds of this species calling from burrows during the day, as well as many of both Fork-tailed and Leach's Storm-Petrels calling at night. In 1986, we did an occupancy plot on the east island (see account following).

Table EM120-2. Habitat locations of Ancient Murrelet, Cassin's Auklet and Storm-Petrel burrow entrances on west Rankine Island in 1984.

Burrow locations	Ancient Murrelet number	%	Cassin's Auklet number	%	Storm-Petrels number	%
Tree base	33	14.1	14	5.4	0	0
Live tree roots	44	18.8	49	19.1	3	25.0
Stump	46	19.7	36	14.0	1	8.3
Dead tree roots	41	17.5	47	18.3	1	8.3
Log	45	19.2	47	18.3	3	25.0
Rock	5	2.1	8	3.1	0	0
Grass tussock	0	0	1	0.4	0	0
Open ground	8	3.4	18	7.0	4	33.3
Into bank	12	5.1	31	12.1	0	0
Shrubbery	0	0	1	0.4	0	0
Dense herbs	0	0	1	0.4	0	0
Driftwood	0	0	4	1.6	0	0
Totals	234		257		12	

Table EM120-3. Extent of Ancient Murrelet, Cassin's Auklet and Storm-Petrel colonies on west Rankine Island in 1984.

Transect	Ancient Murrelet					Cassin's Auklet					Storm-Petrel				
	Distance along transect* (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Distance along transect* (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Distance along transect* (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevations (m)	Average slope (°)
1	15-225	12	80	3-20	22	0-105 125-257	0	70	3-20	19	0-45	0	13	5-7	21
2	15-330	15	160	3-12	8	0-15 260-345	0	85	3-9	8	0-15	0	15	3	3
3	105-520 560-709	0	260	3-40	9	0-135 615-709	0	85	3-18	12	615-709	0	85	3-5	13
4	45-285 375-823	0	310	2-30	10	0-75	0	50	2-6	8	0-45	0	30	2-4	8
5	15-615	7	210	14-31	5	0-15 585-622	0	26	12-16	6	585-622	0	26	14-16	5
6	75-165 195-375	18	70	2-18	8	0-75 135-195 345-425	0	45	1-14	7	-				

* Note orientation of transects in Table EM120-1; transects 1,2 and 4 begin on the east side and transects 3,5 and 6 begin on the west side.

Table EM120-4. Number of Storm-Petrel burrows in 5mx5m plots along transects on west Rankine Island in 1984. Plots considered to be outside the colony are indicated by a dash.

Plot	Transect 1	2	3	4	5	6
1	1	2	-	2	-	-
2	5	-	-	2	-	-
3-9	-	-	-	-	-	-
10-12		-	-	-	-	-
13-15			-	-	-	-
16-20			-	-	-	
21			-	-	0	
22			2	-		
23			0	-		
24			1	-		
25-28				-		

1984 Nesting Population: Using the median British Columbia occupancy rate of 91%, and the proportion of Fork-tailed Storm-Petrels determined in 1986 on the east island, we arrive at a total estimate of 2363 ± 710 pairs of storm-petrels nesting on the west island: 332 ± 100 pairs of Fork-tailed Storm-Petrels and 2031 ± 610 pairs of Leach's Storm-Petrels.

Black Oystercatcher: In 1984, one nest containing 2 eggs was found on 6 June on the mid-west side of the island on the outer rock. In 1986, two nests were found on the two rocks off the north end: 1 nest with 2 eggs on the southern rock; and 1 nest with 1 egg on the northern rock. Nests were made of mussel, limpet and abalone shells and rock chips.

Glaucous-winged Gull: In 1986, we found one nest with 3 eggs on the northern rock.

Ancient Murrelet: We found Ancient Murrelets nesting over much of the island (Fig. EM120-1) on slopes averaging 5° to 22° (Table EM120-3). They were most abundant on seaward facing slopes, but we found some burrows in the interior of the island surrounded by inland facing ridges and sphagnum bogs. Most burrows were located on open forested slopes, but there were many burrows in the old windfall at the southeast corner, as well as on the edges of the windfall on the west side. Burrow entrances occurred primarily under tree bases, roots, stumps, and logs (Table EM120-2). The mean length of a sample of 99 burrows was 51 ± 2 cm.

Number of sample plots:	Higher density:	73
	Lower density:	16
	Overall:	89 (2225m^2 - 0.6% of colony)
Average Density:	Higher density:	1240 ± 120 burrows/ha
	Lower density:	150 ± 60 burrows/ha
	Overall:	1042 ± 105 burrows/ha (Table EM120-5)
Colony Area:	38.3 ha	
Total Burrows:	39,909 ± 4022	
1985 Occupancy Rate:	65.6 ± 7.7% (42 of 64 known; Table EM120-6)	
1985 Nesting Population:	26,180 ± 4041 pairs	

Table EM120-5. Number of Ancient Murrelet burrows in 5mx5m plots along transects on west Rankine Island in 1984. Plots considered to be outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

	Transect					
Plot	1	2	3	4	5	6
1	-	-	-	-	-	-
2	1	1	-	-	6	-
3	2	0	-	2	1	-
4	1	2	-	4	4	5
5	6	6	4	4	3	5
6	3	9	1	2	1	5
7	2	3	1	4	3	-
8	3	9	5	6	1	7
9	-	3	2	4	0	5
10		2	1	1	3	2
11		0	4	-	8	4
12		1	2	-	3	13
13			4	-	1	0
14			1	0	0	-
15			0	0	2	-
16			0	1	0	
17			0	0	3	
18			2	1	3	
19			-	0	3	
20			3	4	8	
21			2	0	1	
22			0	3		
23			0	1		
24			1	0		
25				3		
26				5		
27				0		
28				0		

Table FM120-6. Occupancy of Ancient Murrelet Burrows along transects and in permanent plots on west Rankine Island in 1984.

Date	Location: Tran	Location: Plot	Empty	1 cold egg	2 cold eggs	Adult+ 2 eggs	Adult+ 1 chick	Adult+ 2 chicks	Hatched membrane	Total occupied	Total known
31/5	1	2							1	1	1
31/5	1	5			1			1		2	2
31/5	1	6						1		1	1
1/6	1	7				1			1	2	2
1/6	1	8	1							0	1
30/5	2	4	1						1	1	2
30/5	2	5				1		1		2	2
31/5	2	6	5							0	5
31/5	2	7				1				1	1
31/5	2	8		1						1	1
31/5	2	10			1					1	1
31/5	2	12	1							0	1
1/6	3	5	1					1		1	2
1/6	3	6							1	1	1
1/6	3	8					1	1	1	3	3
2/6	3	12	1							0	1
2/6	3	14				1				1	1
2/6	3	18			1					1	1
2/6	3	21		1						1	1
1/6	4	4	1							0	1
1/6	4	7				1				1	1
1/6	4	9	1							0	1
2/6	5	4	2							0	2
4/6	5	19			1					1	1
4/6	5	20	1						2	2	3
4/6	6	4	1		1	2				3	4
4/6	6	5	1					1	1	2	3
4/6	6	6	3						1	1	4
5/6	6	8				1			2	3	3
5/6	6	9				2				2	2
5/6	6	11				1			1	2	2
5/6	6	12	2					1	4	5	7
Totals			22	2	5	11	1	7	16	42	64
	Perm Plot*										
6/6	1		2			4			10	14	16
6/6	2								3	3	3
4/6	3								2	2	2
5/6	4		1	2		1			6	9	10
6/6	5		1			3			5	8	9
6/6	6		4		2				1	3	7
5/6	7		5	1					1	2	7
5/6	8		1						1	1	2

* Burrows in permanent plots were not examined to determine occupancy, but the following contents were incidentally ascertained. These were not included in the sample to calculate an occupancy rate.

Staging Area: Ancient Murrelets were observed staging north and south of the west Rankine Island, and to the east as far as 1km east of the east Rankine Island (Fig. EM-2).

Cassin's Auklet: Cassin's Auklets were burrowing around most of the perimeter of the island, to a maximum of 85m from shore, though usually within 20m of the shore rock (Fig EM120-1). Density was higher on the east side of the island. Burrows occurred in mossy and grassy areas under roots, logs, windfall, stumps, and rock (Table EM120-2). The mean length of 28 burrows was 83 $\pm$ 7cm.

Number of sample plots: 33 (825m^2 - 0.7% of colony)

Average Density: 3103 $\pm$ 493 burrows/ha (Table EM120-7)

Colony Area: 11.3 ha

Total Burrows: 35,064 $\pm$ 5571

Table EM120-7. Number of Cassin's Auklet burrows in 5mx5m plots along transects on west Rankine Island in 1984. Plots considered outside the colony are indicated by a dash.

	Transect					
Plot	1	2	3	4	5	6
1	26	9	4	27	13	18
2	9	-	2	7	-	0
3	8	-	7	2	-	8
4	2	-	5	-	-	-
5	-	-	1	-	-	-
6	10	-	-	-	-	1
7	13	-	-	-	-	1
8	5	-	-	-	-	-
9	10	-	-	-	-	-
10		3	-	-	-	-
11		0	-	-	-	-
12		6	-	-	-	-
13			-	-	-	2
14			-	-	-	6
15			-	-	-	22
16-20			-	-	-	
21			-	-	12	
22			0	-		
23			9	-		
24			8	-		
25-28				-		

Table EM120-8. Occupancy of Cassin's Auklet burrows along transects and in permanent plots on west Rankine Island in 1984.

Date	Location: Transect	Location: Plot	Empty	Cold egg	Adult + egg	Adult + chick	Chick	Hatched membrane	Total occupied	Total known
30/5	1	1	3		3	1	3		7	10
31/5	1	3			1				1	1
1/6	1	7					1		1	1
1/6	1	8				1			1	1
1/6	1	9	1						0	1
30/5	2	1	1			1			1	2
31/5	2	12	1						0	1
31/5	3	1			1		1		2	2
2/6	3	24					1		1	1
1/6	4	1		1					1	1
1/6	5	1	1						0	1
4/6	5	21	1						0	1
2/6	6	1	2	1					1	3
4/6	6	3	1		1		1		2	3
Totals			11	2	6	3	7		18	29
Perm. Plot*										
6/6	1		2				2		2	4
4/6	2						2		2	2
5/6	4						2		2	2
4/6	5						1		1	1
6/6	6		1				1		1	2
5/6	7				1				1	1

* Burrows in permanent plots were not examined to determine occupancy, but the following contents were incidentally ascertained. These were not included in the sample to calculate an occupancy rate.

1985 Occupancy Rate: 62.1 ± 7.4% (18 of 29 known; Table EM120-8)

1985 Nesting Population: 21,775 ± 4306 pairs

Predation

Considerable evidence of predation on Ancient Murrelets was recorded within the surveyed quadrats (47 feather piles, 8 single wings, 2 detached heads, 22 depredated eggshells, and 28 eagle pellets containing feathers; Table EM120-9). Using feather piles as a minimum indication of the number of birds that had been preyed upon, we calculated an average density of 210 ± 33 depredated birds/ha, giving a total estimate of 8085 ± 1250 Ancient Murrelets that had preyed upon during the 1984 season up to the time of our survey. Making the same calculations for depredated eggs gave an average density of 99 ± 23 depredated eggs/ha, and a total estimate of 3782 ± 891 eggs that had been preyed upon this season up to the time of our survey.

Table EM120-9. Depredated remains of Ancient Murrelets and Cassin's Auklets in 5mx5m plots along transects on west Rankine Island in 1984.

Transect	Plot	ANMU feather pile	ANMU single wing	ANMU head	Depredated ANMU egg	CAAU feather pile	CAAU carcass	BAEA pellet with feathers
1	2	1						
1	4	1						
1	5							1
1	6							1
1	8					1		
2	1					1		
2	2	1	1					
2	3	3	2					
2	4	2			1			
2	5	1			1			
2	6	3	1					
2	7	2	3		1			
2	8	1			1			1
2	9							1
2	10	1			1			
2	12	1		1				1
3	1						1	
3	2					1		
3	5	1						
3	6	1			1			
3	7	1						
3	9	1			1			
3	11	2						
3	12				1			
3	14	1						
3	17				1			
3	18	2						
3	21							5
3	24	1		1				
4	5							1
4	8	1						
4	9	1						
4	10							1
4	20	1						
4	25	2			2			3
4	28	1						
5	2	1						
5	3	2						1
5	11	1						
5	12							2
5	17	2	1					
5	18	1			1			
5	19							1
5	20	1						1
5	21				1			
6	1							4
6	4	1			1			

Table EM120-9. cont'd

Transect	Plot	ANMU feather pile	ANMU single wing	ANMU head	Depredated ANMU egg	CAAU feather pile	CAAU carcass	BAEA pellet with feathers
6	5	2						
6	6				2			1
6	8	1						
6	9				1			
6	10	2			3			
6	11				1			
6	12				1			
6	13							2
6	14							1
Totals		47	8	2	22	3	1	28

Less predation on Cassin's Auklets was recorded in the quadrats (3 feather piles and 1 decapitated carcass). Again using the number of feather piles we calculated the average density of predation to be 36 ± 20 birds/ha, giving a total estimate of 410 ± 229 Cassin's Auklets preyed upon in the 1984 season up until the time of our survey.

Nocturnal Activity

The west Rankine Island at night is a pandemonium of seabird activity. The general sequence of activity during the time we were on the island was as follows:

2245-2305hrs. Ancient Murrelet adults and chicks heard on water.

2235-2320hrs. First birds flying in.

2300hrs. Ancient Murrelets and Cassin's Auklets first calling on colony.

2315-2354hrs. First petrels calling.

2400-0300hrs. Crescendo of activity.

0320hrs. Petrels stopped calling.

0340hrs. Ancient Murrelets stopped calling.

0356hrs. Cassin's Auklets stopped calling. All quiet.

0415hrs. Last bird flying out.

0430hrs. Hermit Thrushes singing.

EAST ISLAND

Description: The east Rankine Island is a small 7.4ha island, with extensive bare rocky areas around the shore. The terrain varies from steep knolls and bluffs to areas of level ground. Slopes rise to a maximum elevation of approximately 25m. Lush grass and forbs grow under an sparse stand of spruce towards the south end of the island. The northern portion is covered with a dense, young stand of spruce with little ground vegetation in the interior.

Nesting Seabirds

Storm-Petrel: Petrel burrows were found throughout the vegetated area of the island under the lush forb growth as well as in the bare ground under the regenerating spruce.

Number of sample plots: 12 ($108m^2$ - 0.5% of colony)

Average Density: 5730 ± 1380 burrows/ha (Table EM120-10)

Colony Area: 2.3 ha

Total Burrows: 13,179 ± 3174

Table EM120-10. Number of Storm-Petrel burrows in 3mx3m plots along transects on east Rankine Island in 1985.

	Plot					
Transect	1	2	3	4	5	6
1	9	1	3	4	14	1
2	1	1	8	3	8	9

1986 Occupancy Rate: In 1985, both species of storm-petrel were heard from burrows on the island, but no ratio or occupancy rate was determined as we were too early in the season to obtain an accurate indication of the Leach's Storm-Petrel population. We returned in 1986 to obtain an occupancy rate. The plot for occupancy was done in the middle low section of the east island in the bare forest floor under young spruce. Table EM120-11 details what we found.

Table EM120-11. Storm-Petrel occupancy plot on the east Rankine Island in 1986.

Total explored	Burrow contents Unk*	Emp	ColdE	FTSP 2Ad	FTSP Ad+E	FTSP Total	LSPE 1Ad	LSPE 2Ad	LSPE Ad+E	LSPE Total
54	29	9	1	1	2	3	4	4	4	12

* Unknown. Burrows explored but contents not determined.

Occupancy rate = 64% (16 occupied of 25 known)

FTSP:LSPE = 1:4 (N=15)

We suspect the occupancy rate and percentage of Leach's Storm-Petrels may be underestimated by the above figures because it was early in the season, and so have used the median British Columbia occupancy rate to calculate a population estimate for Leach's Storm-Petrels.

Range of length of burrows whose contents were determined was 30 to 100cm (Average = 68 ± 20cm). Unknown burrows were > 70cm.

1985 Nesting Population: Using the median British Columbia occupancy rate of 91% on the number of burrows calculated in 1985, and the proportion of Fork-tailed Storm-Petrels determined in 1986, gives a total estimate of 11,993 ± 2888 pairs of storm-petrels nesting: 1687 ± 406 pairs of Fork-tailed Storm-Petrels and 10,306 ± 2482 pairs of Leach's Storm-Petrels.

Black Oystercatcher: In 1985, we found 1 nest with 2 eggs on a small grass patch on an upper rock shelf. Nest was made of rock chips and a few mussel shell fragments. In 1986, 1 empty scrape and 2 nests with 1 young each were found on the south point. We suspected chicks around the empty nest. Nests were made of mussel, limpet and abalone shells and rock chips.

Glaucous-winged Gull: In 1985, no nest count was made, but we counted 96 adults standing on territories at 1730hrs on 7 June. Thirty-five other gulls, including 6 immatures were roosting on the tidal rocks below the colony. In 1986, the following count was made:

	Emp	1E	2E	3E	Total
S pt. of E island	1		2	39	42

Nests were made of grass, Cochlearia, and seaweed.

Pigeon Guillemot: No nests were found. Twelve birds were on the water at the south end of the island at 1730hrs on 7 June 1985.

Cassin's Auklet: Cassin's Auklets were burrowing over much of the island, but were absent from the interior of the dense spruce forest (Fig. EM120-1). Burrows extended to a maximum of 40m from shore, but were most abundant around the perimeter under grass and roots.

Number of sample plots: 12 ($108m^2$ - 0.5% of colony)

Average Density: 3050 ± 1340 burrows/ha (Table EM120-12)

Colony Area: 2.1 ha

Total Burrows: 6405 ± 2814

1985 Occupancy Rate and Nesting Population: An occupancy rate was not determined in 1985. Using the 1984 rate for the west island of 62.1 ± 7.4%, our estimate of the nesting population would be 3978 ± 1799 pairs.

Table EM120-12. Number of Cassin's Auklet burrows in 3mx3m plots along transects on east Rankine Island in 1985.

	Plot					
Transect	1	2	3	4	5	6
1	5	1	0	1	0	3
2	15	3	3	1	0	1

Predation

Signs of predation were evident but not abundant. We found the remains of Ancient Murrelet (1 feather pile), Cassin's Auklet (1 feather pile, 1 single wing, 1 pair of wings, and 1 foot), Rhinoceros Auklet (1 feather pile), and Sooty Shearwater (4 feather piles). There was one Bald Eagle nest on the island.

POPULATION SUMMARY FOR EAST AND WEST RANKINE ISLANDS

(Data combined from 1984, 1985, and 1986 surveys)

	West Island	East Island	Total (pairs)
FTSP	332 ± 100	1687 ± 406	2019 ± 418
LSPE	2031 ± 610	10,306 ± 2482	12,337 ± 2556
BLOY	2	3	5
GWGU	1	42	43
ANMU	26,180 ± 4041	0	26,180 ± 4041
CAAU	21,775 ± 4306	3978 ± 1799	25,753 ± 4667
PIGU		12 (birds)	12 (birds)

Associated species: Records from 1984 unless otherwise noted.

Pelagic Cormorant - 16 immatures in 1985.

Bald Eagle: A total of 8 nests were found on the west island, 2 of which appeared to be active in 1984. See Fig. EM120-1 for locations corresponding to the numbers below.

1. 20m high in 40m tree 40m from shore. No activity.
2. 20m high in 40m cedar snag, 15m from shore. 2 adults present.
3. Top of 25m spruce snag 70m from shore, 150m from #1. No activity.
4. Behind NE chute bay 20m high in 28m spruce, 100m from shore. Adult perched high nearby.
5. 15m high in 35m spruce 3m from shore. Empty.
6. 30m high in 32m spruce snag 4m from shore. No activity.
7. 25m high in 30m cedar tree 20m from shore. 2 adults present.
8. 30m high in 35m spruce 100m from shore. 80m from #7. No activity.

One nest was found on the east island: 23m high in 90cm dbh spruce, 5m from shore rock on the southeast side. Adult nearby in 1985.

Bald Eagles were frequently seen perched low in the interior forest of the west island in the day time. Towards evening and into the night they were encountered in the Ancient Murrelet colony areas. Numerous Ancient Murrelet feather piles and Bald Eagle pellets were found on the forest floor.

Peregrine Falcon - 1 on 29 May and 1 June

Common Murre - 12 on 5 June

Rhinoceros Auklet - 5 south of the island

Northwestern Crow: One nest with one feathered young was found on 2 June on the south-west corner of the west island. The nest was on a ledge of a small cliff under over-hanging salal just above the beach rock. A maximum of 15 crows were seen on 29 May. One nest was observed on the east island but contents were not determined.

Common Raven

Sitka Deer - pellets and the beginnings of trails observed on the east island. One petrel burrow entrance had been stepped through by a deer.

River Otter - runs and scats containing fish

EM-130 MARION ROCK 103 B/6

Location: At the south-east corner of Collison Bay.

52°17'27"N 131°06'27"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (1155-1200hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Small, bare, 3m high rock.

Nesting species:

Black Oystercatcher: 4 adults present. One empty scrape was found, and there was one Black Oystercatcher egg in the Glaucous-winged Gull nest (see below).

Glaucous-winged Gull: One nest had 2 Glaucous-winged Gull eggs and 1 Black Oystercatcher egg. The Glaucous-winged Gull was incubating all 3 eggs. The nest was made of grass and moss. Only one adult gull was present.

EM-140 NEST ISLETS 103 B/6

Location: In Collison Bay. 52°17'35"N 131°07'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (1205-1235hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration and total count.

Description: The smaller south-east islet is mostly bare rock with grass and a few spruce trees on the top. The north-west islet is forested with spruce and redcedar with grass and moss around the edges. They total 7.5ha in area.

Nesting species:

Black Oystercatcher: We found the following nests:

	Emp	1E	2E	Total	Adults	
SE islet	1			1	2	(broken eggshell nearby)
NW islet			3	3	6	
TOTAL	1		3	4	8	

Two nests were just depressions in the grass and moss, one with a few shells; the other 2 were on rock, one with rock chips and one with shells. One nest with 2 eggs had a third, cracked egg in a puddle outside the nest.

Pigeon Guillemot: 25 adults were on the rocks on the south-east islet. We found no sign of nest sites, though there were suitable crevices and boulders.

Associated species:

Bald Eagle - 2

River Otter - runs on the SE islet

EM-150 INNER LOW ROCK 103 B/6

Location: North of Ikeda Point. 52°19'22"N 131°08'33"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (1245-1254hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Description: Bare rock with scattered Potentilla villosa.

Nesting species:

Black Oystercatcher: 1 nest with 2 eggs. On rock with a few rock chips and shells. 4 adults.

EM-160 JOYCE ROCKS 103 B/6

Location: North of Ikeda Point. 52°20'10"N 131°08'20"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 8 June 1985 (1930hrs) and 19 June 1986 (1300-1430hrs).

Colony access: Drop-off from boat.

Observers: 1985: M. Rodway, M. Lemon. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: In 1985, we made a count from the boat only. We did a total count in 1986.

Description: Joyce Rocks consist of two groups of tidally connected rocks with a passage between them. The five rocks, 2 northern and 3 southern, have a total area of 0.7ha. They are mostly bare with some grassy patches.

Nesting species:

Black Oystercatcher: There were 4 present in 1985. In 1986, we found 1 nest with 1 egg. It was made of rock chips.

Glaucous-winged Gull: We counted 225 adults standing on territory in 1985. In 1986 there were the following numbers of nests:

		Start	Empty	1E	2E	3E	Total
NE group:	N rock		1	7	18	44	70
	S rock	1	2	10	7	17	37
SW group:	SE rock	2	1	4	14	34	55
	Middle rk	1	2	4	10	15	32
	SW rock	1	1		1		3
TOTAL		5	7	25	50	110	197

Nests were made of seaweeds (Fucus, eelgrass, and others) and grass. A number of nests were situated very low on the rocks - in the black algae zone, as low as 1.5m above the barnacle zone. Heavy seas in any kind of storm would have washed these lower nests away. We found one dishevelled nest with 3 broken eggs. One empty nest had one broken egg and one displaced egg in a nearby puddle.

Pigeon Guillemot: In 1986, there were 9 adults between the rocks.

Associated species:

Hair Seal - 3 in 1985, 10 in 1986.

EM-170 SEA PIGEON ISLAND 103 B/6

Location: In Huston Inlet at the south-west corner of Skincuttle Inlet.

52°17'09"N 131°17'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 May 1985 (1250-1400hrs).

Colony access: Boat landing on beach on south-west corner.

Observers: M. Rodway, D. Garnier.

Census method: Exploration.

Description: This moderately sloped, 4.2ha island rises to a height of 69m. Salal covers most of the ground under hemlock, spruce and cedar. There are open bare and mossy areas in the interior and on the north side, especially at the north-east corner. Some large redcedars have recently blown down in the interior toward the east end. On the mid-north side is a large hemlock stump with springboard holes.

Nesting species: We found no sign of burrowing by seabirds.

Pigeon Guillemot: 5 were seen off the north and west side and may have nested later in the season.

Associated species:

Bald Eagle

Northwestern Crow

River Otter - Dens, runs and scats.

Sitka Deer

Racoon - scats.

EM-180 BOULDER ISLAND 103 B/6

Location: On the west side of Huston Inlet.

52°17'30"N 131°17'40"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 17 May 1985 (1120-1245hrs).

Colony access: Boat landing on beach at south tip.

Observers: M. Rodway, D. Garnier.

Census method: Exploration.

Description: This is a rounded, 5.6ha island with moderate slopes. Under a hemlock, redcedar and spruce forest is mostly open bare and mossy ground with scattered huckleberry, salal and copperbush (Cladothamnus pyrolaeflorus). The salal has been heavily browsed by the deer. Alder and crabapple occur along the shore. There is considerable old and new windfall throughout the island, especially through the center and east sides. At the south end is a grassy (Elymus mollis) spit with a fine beach on either side. On the west side towards the south end are some large redcedar stumps with springboard holes. There are fire blackened snags and logs in this area as well.

Nesting species: No signs of use by seabirds were found.

Associated species:

Black Oystercatcher - 2 on the south spit flew away.

Bald Eagle - 1 inactive nest at the north end, 50m high in 60m spruce 8m from shore. 2 skeletons and 1 recently dead eagle were found on the forest floor. No live birds were seen.

Racoon - Lots of scats under roots and tree hollows.

Sitka Deer

EM-190 GREEN ROCK 103 B/6

Location: In Huston Inlet at the west end of Skincuttle Inlet.

52°17'34"N 131°17 04"W

Land Status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 17 May 1985 (1400-1430hrs) and 19 June 1986 (1820-1840hrs).

Colony access: Drop-off from boat.

Observers: 1985: M. Rodway, D. Garnier. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This is a beautiful little eroded limestone rock with many sinkholes, arches and crevices. It is covered with a lush growth of Elymus, Conioselinum, and Mimulus guttatus in the sinkholes and interior pockets in the limestone.

Nesting species:

Black Oystercatcher: In 1985, we found 2 nests - 1 with 2 eggs and 1 empty. Nests were made of shell on worn dirt bowls in the grass. There were 5 adults present. In 1986 we recorded the following nests:

2E	3E	Total	Adults
2	1	3	6

Nests were made of rock chips and mussel, clam and limpet shells. Two were on rock, one on a worn dirt bowl in the grass.

Glaucous-winged Gull: In 1985 we found 2 nest starts with 4 adults present. In 1986, there were 3 nests with 3 eggs each. They were made of grass and hidden in the Elymus.

Pigeon Guillemot: In 1985, there were 4 birds present. They were nesting in rock crevices but there were no eggs yet. In 1986, we found the following nests:

1E	2E	3E	Adults
1	3	1	21

They were nesting in burrow-like crevices in sunken pockets in the limestone in the middle of the island (10m from edge). Nest entrances were often concealed by the lush Elymus. Birds had to "helicopter" up out of these depressions before they could fly to sea.

EM-210 BUSH ROCK 103 B/6

Location: At the mouth of Huston Inlet. 52°18'22"N 131°16'34"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 May 1985 (1430-1445hrs) and 19 June 1986 (1810-1816hrs).

Colony access: Drop-off from boat.

Observers: 1985: M. Rodway, D. Garnier. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: This is a small two-lobed rock covered with grass and Sedum divergens There are 2 spruce shrubs and 1 pine shrub decorating the southern knob.

Nesting species:

Black Oystercatcher: In 1985, we found 1 nest with 3 eggs. The nest was made of barnacle, crab and Red Turban shells. 2 adults were present. In 1986, 2 adults were present but they were not defensive and no nest was found.

Pigeon Guillemot: 1 adult flew off the rock in 1986.

Associated species: (1985)

Sitka Deer - Curled up under dwarf pine tree.

EM-220 BOLKUS ISLANDS 103 B/6

Location: At the west end of Skincuttle Inlet. 52°19'30"N 131°16'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 3 May (Exploration), 14 and 17 May (Transects), and 15 May 1985 (Survey of small east islands). The rock at the east end was revisited on 19 June 1986 at 1718-1722hrs.

Colony access: Beach landings on the mid-south side and on the north-west corner of the main island. Crews were dropped off on the east end of the main island and on all the eastern islands. In calm weather we landed the boat on the south side of island #7.

Base camp: We did not camp on Bolkus Islands (our camp was on East Copper Island), but camping appeared feasible at the two landing sites listed above, though the area around the mid-south bay was quite wet. Drinking water may be a problem at both sites.

Observers: 1985: M. Lemon, M. Rodway, D. Bertram, D. Powell, D. Garnier, and D. Power. 1986: M. Rodway, D. Garnier and D. Grinnell surveyed the rock at the east end.

Census Method: Exploration, partial count, and line transects. On the eastern section of the main island, 45 quadrats (7mx7m) were surveyed at 30m intervals along 4 transects run at 180° (Fig. EM220-1). A strip transect 2m wide and 125m long was surveyed across islet #7.

Description: The Bolkus Islands consist of one main island (60.5ha) with a group of four vegetated islets (0.4ha) connected by the tide to its east point, plus a chain of seven small islands (14.0ha) off the east end. The total area of the islands is 74.5ha. According to marine charts, the main island reaches a maximum elevation of 79m at the east end, and the eastern islands are as high as 55m. These are likely overestimates as our highest altimeter reading along transects was 30m. There is a beach in the large bay on the mid-south side, and around the northwest corner of the main island, otherwise the shoreline is rocky. Most of the west half of the main island is low and undulating, with many wet seepage areas. There is a gradually rising ridge towards the east point which becomes precipitous on its south face. Another ridge rises towards the northeast point, though its sides are not as steep. Between these two ridges a low valley runs through to the main mid-south bay. The smaller eastern islands have rocky shores and minimal to moderate slopes, with some steeper knolls in their interiors.

All islands except the east rock, are forested with a mix of spruce, hemlock and redcedar. The total vegetated area on the islands is 60.5ha (52.2ha on the main island and 8.3ha on the east islands; Table EM220-1). The majority of the ground cover on the main island is moss, but there are patches of spruce seedlings and hemlock saplings in open and windfall areas, and salal becomes more abundant on the south face of the east ridge until it covers 90% of the ground at the east end. The north slopes are

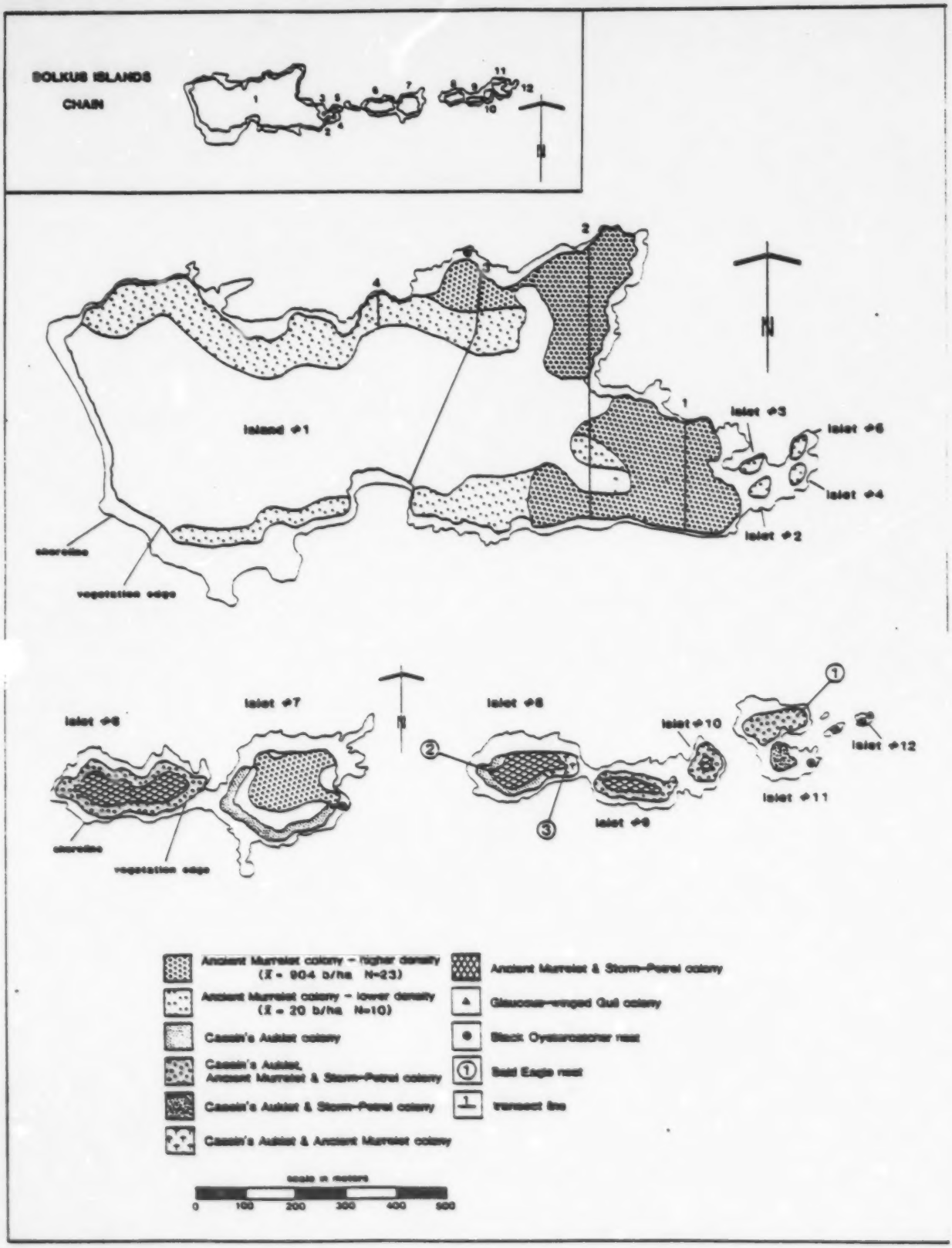

Figure EM220-1. Seabird colony areas and transect locations on Bolkus Islands in 1985.

more open. There has been a lot of windfall on the main island. Large tracts have fallen in the past towards the northwest end, in the middle, through the low valley between the east and northeast ridges, and on the northeast ridge, and very recent sections on the northeast ridge had fallen just before our survey. The understory on most of the smaller islands is a mix of thick salal and small, open mossy patches. Island # 11 has more open mossy and grassy areas, as well as patches of young regenerating spruce, and island # 7 has a large open mossy area in the interior. The rock at the east end is mostly bare rock with a few flowers.

Table EM220-1. Colony area and numbers of Ancient Murrelet burrows counted and estimated on Bolkus Islands in 1985.

Island	Vegetated area (ha)	Colony area (ha)	Burrows counted	Total burrows estimated
1 transected area*	52.2	16.5	103	10,477 ± 1,450
1 west half		5.5	12	150
2	0.09	0.09	7	10
3	0.09	0.09	28	40
4	0.09	0.09	8	8
5	0.09	0.09	19	19
6	2.14	2.14	62	122
7	3.09	1.57	14	875
8	1.09	1.09	35	40
9	0.66	0.66	18	60
10	0.28	0.28	11	25
11	0.71	0.71		50
Totals	60.5	28.8		11,876 ± 1,450

* Transect surveys were limited to the eastern half of island #1, see text.

Nesting Species

Storm-Petrel: We found petrel burrows on islands #6-11 in the eastern chain. Burrows were located in mossy areas both near shore and in the interior surrounded by salal. The total number of burrows was estimated to be 250. (See Table EM220-2 for a list of burrows found on each island.) No petrels were pulled from burrows. Two Fork-tailed Storm-Petrel feather piles were found. We estimated 230 pairs of Storm-Petrels nesting.

Black Oystercatcher: In 1985, four pairs of oystercatchers were observed, and four empty scrapes were found on 14 and 15 May: 1 on the mid-north side of the main island; 1 on island #7; and 2 on island #11. On the east rock (#12) in 1986, we found 2 empty scrapes of limpet, mussel and chiton shells on worn dirt bowls. There were 2 adults present.

Glaucous-winged Gull: On the east rock in 1986 there was 1 grass nest with 3 eggs. 1 adult was present.

Table EM220-2. Numbers of burrows counted, and estimated total burrows of Storm-Petrels, Cassin's Auklets and Rhinoceros Auklets on Bolkus Islands in 1985.

	Storm-Petrels		Cassin's Auklets		Rhinoceros Auklets	
Island	Burrows counted	Total burrows estimated	Burrows counted	Total burrows estimated	Burrows counted	Total Burrows estimated
6	42	52	256	256	9	9
7	3	10	113	175	2	5
8	30	30	71	71	1	1
9	7	30	8	30	1	4
10	8	25	54	75	4	10
11	10	100	175	675	-	-
Totals		247		1,282		29

Pigeon Guillemot: A maximum of 41 birds were counted: 8 on the north side of the main island on 14 May, plus 33 on the south side on 15 May. We suspect they were nesting later in the season.

Ancient Murrelet: Ancient Murrelet burrows were found on every island in the Bolkus chain except the east rock (Table EM220-1). Burrowing was most abundant and extensive around the east and northeast ridges of the large island (Fig. EM220-1; Table EM220-3). Sporadic patches of burrowing occurred over most of the north and south coasts of the main island, and on all the smaller islands. Burrows were located primarily in mossy areas under roots, stumps, tree bases and logs (Table EM220-4), but some were found under salal, spruce seedlings, and windfall. The mean length of 17 burrows where occupancy was determined was 54 $\pm$ 4cm.

Number of sample plots: Higher density: 23
Lower density: 10
Overall: 33 (1617m^2 = 1.0% of transected area)

Average density: The average density on the transects was 636 $\pm$ 88 burrows/ha (Table EM220-5). Higher density was 904 $\pm$ 73 burrows/ha; lower density was 20 $\pm$ 20 burrows/ha.

Colony area: The nesting area for Ancient Murrelets was 16.5ha in the transected area at the east end of the main island and totalled 28.8ha on the whole island chain (Table EM220-1).

Total burrows: 10,477 $\pm$ 1450 burrows in the main colony area, plus an estimated 150 over the west half of the large island, 77 on islands #2-5, and 1172 on islands #6-11, giving an overall total of 11,876 burrows for the Bolkus Islands (Table EM220-1).

Table EM220-3. Transect parameters and extent of Ancient Murrelet colony on Bolkus Island in 1985.

Transect parameters								Extent of colony			
Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max. (m)	Average slope (°)	Range of slope (°)	Distance along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevations (m)
1	180	227	3	5	30	21	3-38	0-227	0	77	3-30
2	180	517	3	3	15	11	0-25	0-251 315-405 465-517	0	130	3-15
3	180	463	3	1	5	8	0-41	0-165 378-463	0	165	1-5
4	180	67	3	2	3	10	0-27	0-45	0	45	2-3

Table EM220-4. Habitat locations of Ancient Murrelet burrow entrances along transects on Bolkus Island in 1985.

Burrow location	Number of burrows	Percent of total
Tree base	8	7.8
Live tree roots	39	37.9
Stump	19	18.4
Dead tree roots	10	9.7
Log	18	17.5
Rock	2	2.0
Open ground	3	2.9
Into bank	4	3.9
Total	103	

Table EM220-5. Number of Ancient Murrelet burrows in 7mx7m plots along transects on Bolkus Island in 1985. Plots considered outside of the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Plot	Transect 1	2	3	4
1	**6**	**4**	**5**	0
2	**8**	**6**	**3**	0
3	**0**	**5**	**3**	-
4	**4**	**4**	0	-
5	**6**	**4**	0	
6	**4**	**6**	0	
7	**4**	**6**	-	
8	**6**	**3**	-	
9		**6**	-	
10		-	-	
11		-	-	
12		**2**	-	
13		0	-	
14		1	0	
15		-	0	
16		-	0	
17		**4**		
18		**3**		

1985 Occupancy rate: 83.3 ± 9.4% (15 of 18 known)

1985 Nesting population: 9,892 ± 1558 pairs.

Nesting Chronology: Most murrelets (73%) were incubating 2 eggs at the time of our survey (14 and 17 May) (Table EM220-6).

Staging: On 15 May at 1900hrs, Ancient Murrelets were staging off the south side of Bolkus Islands through the middle of Skincuttle Inlet. Birds were gathered along a band from the west to the east end of the island chain (Fig. EM-2). On a single run through this area 3700 Ancient Murrelets were counted. Small numbers of feeding birds were observed on many occasions at various locations around the Bolkus Islands, but we only observed staging off the south side. Murrelets also staged off the south side of the Copper Islands and beyond into Hecate Strait (see Skincuttle Island).

Table EM220-6. Occupancy of Ancient Murrelet burrows along transects on Bolkus Island in 1985.

Date	Transect	Plot	Contents: Empty	2 cold eggs	Adult +1 egg	Adult +2 eggs	Adult +2 chicks	Adult +unk.	Total occupied	Total known
14/05/85	1	2			1	1			2	2
14/05/85	1	4	1						0	1
14/05/85	1	6				2			2	2
17/05/85	2	1	1						0	1
17/05/85	2	3				2			2	2
17/05/85	2	4				1			1	1
17/05/85	2	6					1	1	2	2
17/05/85	2	7		1					1	1
17/05/85	2	8				1			1	1
17/05/85	2	9				1			1	1
14/05/85	3	1	1						0	1
14/05/85	3	2				1			1	1
14/05/85	3	3				2			2	2
Totals			3	1	1	11	1	1	15	18

Cassin's Auklet: Cassin's Auklets were only found nesting on the small eastern islands (#6-11). Most burrows occurred in mossy areas around the perimeters, but they were also located under spruce seedlings, and as far as 5m into salal. Burrows were most abundant on the far eastern island (#11) which has the most open habitat (Table EM220-2). The total number of burrows on these six islands was 1282. No occupancy rate was determined on the Bolkus Islands. Using the median occupancy rate for British Columbia of 75%, we estimated a nesting population of 960 pairs. We found a recently hatched eggshell, indicating that some chicks were present.

Rhinoceros Auklets: We found scattered Rhinoceros Auklet burrows around the perimeters of most of the east islands (#6-10). A total of 29 burrows were estimated (Table EM220-2). No contents were determined. We identified burrows on the basis of size, and on droppings and feathers at the entrances. We suspected 20 pairs nesting.

Predation

We observed considerable signs of predation on the Bolkus Islands. On our exploration of the islands, we noted predation on Ancient Murrelets (91 feather piles, 74 depredated eggs, 9 pairs of attached wings, 8 single wings, and 3 inverted carcasses), mostly on the main island; and on Cassin's Auklets (3 single wings, 2 depredated eggs, 1 pair of attached wings, and 1 feather pile) and Fork-tailed Storm-Petrel (5 feather piles) on the east islands. Signs of Ancient Murrelet predation were found throughout the forest in

the colony area. In the 33 surveyed plots, a minimum of 9 depredated birds and 3 eggs were represented (Table EM220-7). Calculated densities of 56 ± 16 birds/ha, and 18 ± 14 eggs/ha indicate that at the time of our survey, 917 ± 265 birds and 297 ± 231 eggs had been depredated in the 16.5ha of colony that the transects sampled.

Table EM220-7. Depredated remains in 7mx7m plots along transects on Bolkus Island in 1985.

Transect	Plot	ANMU feather pile	Depredated ANMU egg	ANMU wing	ANMU carcass
1	1	1			
1	2	1	2		
1	5		1		
1	8	1			
2	2	1			
2	6	1			
2	8			1	
2	17	1			
2	18	1			1
3	1	1			
3	6	1			
Totals		9	3	1	1

We also found evidence of predation on Glaucous-winged Gulls (3 adults, 2 immatures), Herring Gull, Black-legged Kittiwake, Red-necked Grebe, Mallard, Scoter, and Northwestern Crow. We suspected that Bald Eagles were responsible for most of the predation.

Associated species:

Pelagic Cormorant - 1

Bald Eagle - 15 (6 adults) sighted 3 May on north side. Two active nests (Fig. EM220-1):

1. 20m in 30m spruce 5m from north shore on islet #11. 2 eggs on 15 May.

2. 40m up in 60m spruce 30m from west shore of islet #8. Adult present and excited on 15 May.

3. 35m up in 40m spruce 20m from shore at east end of islet #8. Unoccupied.

Glaucous-winged Gull - 2

Marbled Murrelet - 16 sighted south of Bolkus Island on 15 May.

Northwestern Crow (nests) - A total of 19 nests were found on the 6 east islands with the following contents:

Old	Empty	3E	1E1Y	1E2Y	2Y	4Y	Unknown
5	3	3	1	1	2	1	3*

* 1 chick could be heard.

Young were small and naked with eyes closed and some pin feathers emerging. 6 nests were on the ground under thick salal, 1 nest on ground under windfall debris, 10 nests in spruce saplings, 2 nests in roots or stumps. Nests were made of twigs, lined with moss, grass and shredded redcedar bark. We estimated a total of 40 pairs.

Common Raven

Hair Seal

Sitka Deer

~~EM~~-230 SWAN ISLANDS 103 B/6

Location: Off the south side of Burnaby Island, north-west of the Bolkus Islands. 52°20'N 131°17'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 13 May 1985, 1130-1430hrs (all islands) and 19 June 1986, 1745-1758hrs (grassy rocks at east end).

Colony access: Landing beach on the west side of the largest island. Drop-off from boat for the other islands.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration, and total count on east rocks.

Description: The Swan Islands are low undulating islands with rocky shorelines and a broad beach between the largest island and the connected islet on its west side. Their total area is 24.3ha. On the main island, the forest of spruce, hemlock and cedar has a mossy floor with many wet seepage areas toward the east side. Small hemlock seedlings are growing on many of the drier rises in the interior. The connected knob on the west end of the main

island and the separate western island are covered with similar open mossy forest. The small, eroded limestone rocks at the east end of the islands are covered with grass mixed with Fritillaria camschatcensis and Angelica lucida, and one small spruce shrub.

Nesting species:

Black Oystercatcher: In 1985, we found 3 nests on the eastern grassy rock: 1 empty, 1 with 1 egg and 1 with 2 eggs. There were 2 pairs of adults present. In 1986, we found the following nests on the east rocks.

	1E	2E	Total
N rock	1	2	3
S rock		1	1
TOTAL	1	3	4

Nests were made of rock chips and clam and mussel shells.

Glaucous-winged Gull: In 1985, 2 adults were present on the east rock but there was no nest at this time. In 1986, there was 1 nest with 1 egg on the east rock. The nest was made of grass.

Pigeon Guillemot: 4 birds were seen around the east rocks in both 1985 and 1986.

No active signs of burrowing by seabirds were found. On the east side of the small connected islet, 5 possible storm-petrel burrows were encountered but there was no sign of present use.

Associated species: (1985)

Double-crested Cormorant - 1 immature

Pelagic Cormorant - 1 immature

Bald Eagle

River Otter - Dens, runs and scats.

Sitka Deer

Racoon - Scats around much of the perimeter of the forested islands.

EH-240 "PELICAN" ROCK 103 B/6

Location: Unnamed rock south of Pelican Point on the south-east corner of Burnaby Island. 52°20'40"N 131°15'18"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (1730-1735hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Bare, 4m high rock.

Nesting species:

Black Oystercatcher: 2 nests with 2 eggs. Made of rock chips and shells. 4 adults.

Glaucous-winged Gull: 1 empty nest and 1 dishevelled nest start. Nests made of grass and seaweed. 2 adults.

EH-250 SLUG ISLET 103 B/6

Location: The most southern island in the Copper Islands, at the east end of Skincuttle Inlet. 52°20'18"N 131°13'05"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 May and 10 June 1985, and 19 June 1986, 1630-1705hrs.

Colony access: Drop-off from boat.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Slug Islet is a 4m high, 0.9ha rock, with a grassy center and a clump of four short spruce trees on top. Elymus, Angelica and Mimulus are common. There is a small, bare rock connected by the tide off the south side.

Nesting species:

Black Oystercatcher: In 1985, we found 3 nests on 10 June: 1 with 1 egg made of scallop, mussel, and snail shells, and rock chips laid on gravel; 1 with 2 eggs made of rock chips and a snail operculum laid on gravel; and 1 with 3 eggs made of clam, red turban, and crab shells laid on rock. In 1986, we found 2 empty scrapes. Four adults were present.

Glaucous-winged Gull: In 1985, on 10 June, 14 nests were found: 8 empty, 1 with 1 egg (predated), 1 with 2 eggs, and 4 with 3 eggs. Nests were built of grass and were located on grass and on bare rock. Nests were still being built. There were 50 adults present and we estimated that 25 pairs nested. Other records were kept: on 17 April, 80 gulls were roosting; on 17 May, 28 adults were standing on territories and 82 (including 15 immatures) were roosting.

In 1986, we counted the following numbers of nests:

	Start	Empty	1E	2E	3E	Total
Main islet	4	7		3	25	39
S rock	1	1			7	9
TOTAL	5	8		3	32	48

Nests were made of grass.

Pigeon Guillemot: No nests were found in 1985. On 17 May, 18 adults were present at 1030hrs; on 10 June, 5 were present at 1245hrs. We estimated 9 pairs nesting. In 1986, we found 1 nest with 1 egg under rock. 5 adults were present.

Associated species: (1985)

Bald Eagle - just beginning to build a nest in 1985. Only a few sticks had been placed. In 1986, the completed nest was on a 3m high branch of a low spruce. 1 broken eggshell was at the base of the tree. The nest was empty, but 2 adults were present.

Northwestern Crow

Hair Seal - 57 hauled out; 1 pup.

Including the rocks and islets around Rock Islet, both to the north and south.

Location: At the west end of the Copper Islands group on the north side of Skincuttle Inlet. 52°20'40"N 131°14'10"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 10 June 1985, 1400-1500hrs and 12 June 1985, 0900-1030hrs (Exploration and transects); 16 June 1986 (Occupancy for storm-petrels) and 19 June 1986, 1555-1615hrs (survey of rock north of Rock It., and rock east of Rock It. (connected by tide off the north-east corner).

Colony access: Beach landing on the east side of Rock Islet and the largest islet southeast of Rock Islet. Many of the smaller islets are tidally connected. Isolated ones require boat drop-offs.

Base camp: We camped in the north-east bay on East Copper Island. There is good camping, with water, in Swan Bay.

Observers: 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: D. Powell, H. Hay, N. Holmes (storm-petrel occupancy plot); M. Rodway, D. Garnier, D. Grinnell (islets 9 and 10).

Census method: Line transects: 7 quadrats (3mx3m) set 15m apart were surveyed along 1 line transect run at a bearing of 286° across the main island (#1) for a distance of 98m. Strip transects: 6 strip transects (1m wide) were run across islets #2,3,4,7(2 transects) and 8 (Fig. EM260-1). Burrows were total counted on islet #6. In 1986, surface nesting species were total counted on islets #9 and 10.

Description: This group of 10 islets comprise a total area of 6.0ha, 2.8ha of which are vegetated. They are low islets with mainly rocky shores. A number of them are connected by the tide. Islets #1-8 are forested, predominantly with spruce, plus hemlock and redcedar on the main islet. Crabapple occurs around the perimeters. Much of the understory on these islets is moss or grass, but major portions of islets #1 (east and west ends), #2 (east side), #7 (south-west side), and #8 are covered with thick, young (0.5-1.5m tall) regenerating spruce. There was an old blowdown on the south-west corner of the main islet. The rock north of Rock It. (#10) is a sharply eroded, volcanic rock with many small cavities and crevices. It has a low center vegetated area of Elymus, Lupinus nootkatensis, Angelica and Conioselinum. The rock connected by tide off the north-east corner of Rock It. (#9) is a long, thin, low, eroded limestone rock with little vegetation.

Nesting species:

Storm-Petrel: Storm-Petrels were nesting over all the forested islets (#1-8) (Fig. EM260-1). We found burrows in all areas of these islets, except in the very thickest regenerating spruce. Table EM260-2 shows burrow densities determined from transects, burrowing areas, and total burrows calculated for each islet (See Table EM260-1 for detailed transect results). The total colony area was 2.8ha, and the total number of Storm-Petrel burrows was

calculated to be 18,680.

Table EM260-1. Number of Cassin's Auklet and Storm-Petrel burrows in 3mx3m plots along transect on Rock Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Cassin's Auklet	Storm-Petrel
1	7	2
2	2	3
3	1	11
4	1	3
5	-	6
6	-	4
7	2	5

Table EM260-2. Storm-Petrel burrow density, colony area, and total burrows on Rock Islet and associated islets in 1985.

Islet	Burrows counted	Sampled area(m^2)	Density (burrows/m^2)	Colony area(m^2)	Total burrows
1	34	63	0.5386 $\pm$ 0.1273*	15,100	8147 $\pm$ 1926
2	13	20	0.65	500	325
3	13	20	0.65	500	325
4	18	15	1.20	300	360
5	-	-	0.64**	890	570
6	100	150	0.66	150	100
7	87	135	0.64	8,000	5161
8	83	60	1.38	2,670	3692
Total				28,110	18,680

* We could only calculate a standard error for the densities sampled along the line transect on islet #1:
** For islet #5, we used the density found on #7.

No occupancy was determined in 1985. We returned in 1986 and did an occupancy plot on the south-east section of the main island (#1) in an area of moss and spruce seedlings under a spruce forest (Table EM260-3).

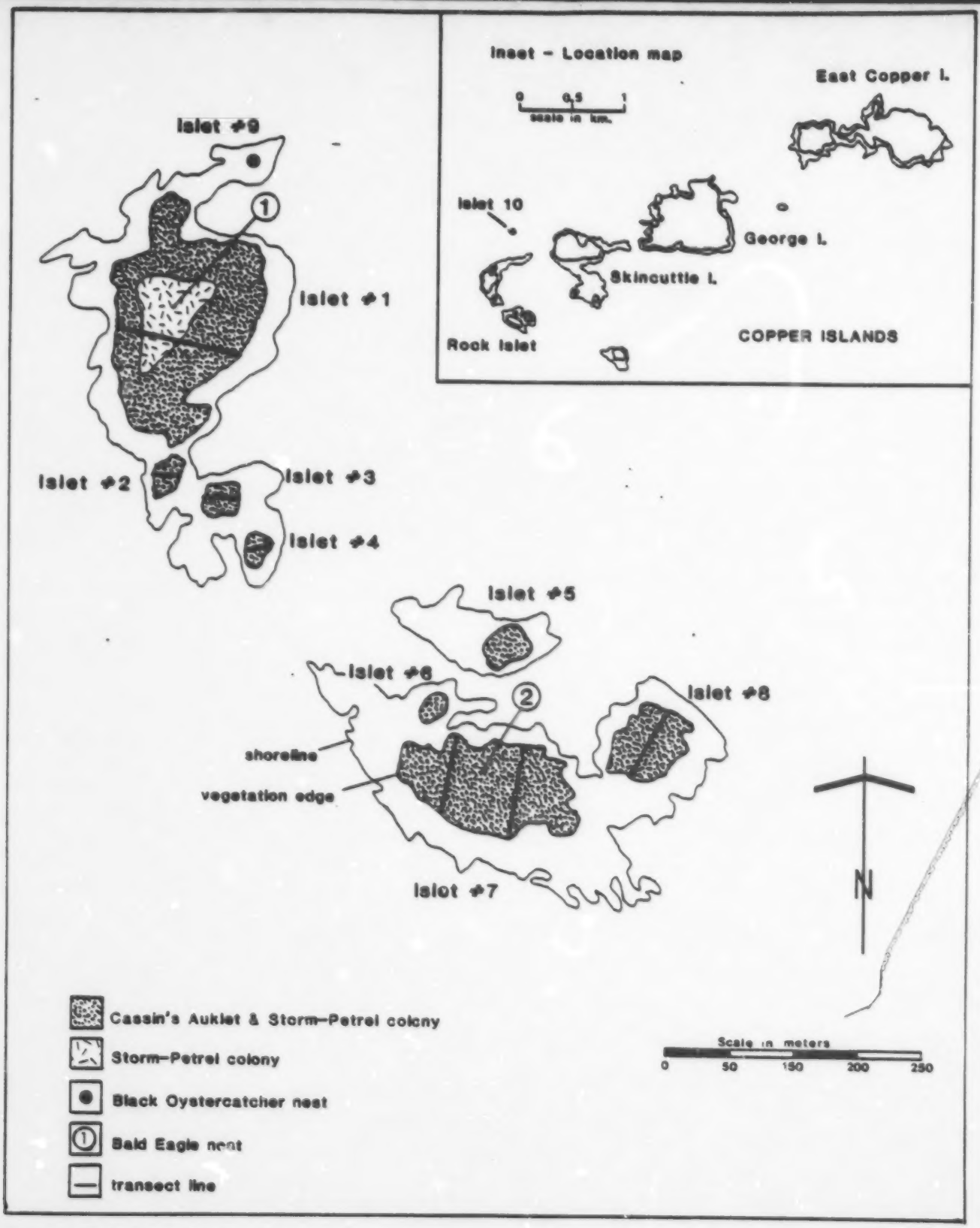

Figure EM260-1. Seabird colony areas and transect locations on Rock Islet and associated islets in 1985.

Table EM260-3. Storm-Petrel occupancy plot on Rock Islet in 1986.

Total explored	Unk*	Emp	ColdE	Burrow contents FTSP Ad	FTSP Ad+E	FTSP Y	FTSP Total	LSPE Ad	LSPE Ad+E	LSPE Total
41	11	15	1	1	5	1	7	2	5	7

* Unknown. Burrows explored but contents not determined.

Occupancy rate = 50% (15 occupied of 30 known)

FTSP:LSPE = 1:1 (n=14)

Seven empty burrows had fresh twigs in them and seven had fresh digging at the entrances. At this time in the season, this could indicate activity by Leach's Storm-Petrels that had not yet begun to nest. We suspect the occupancy rate and the percentage of Leach's Storm-Petrels may be underestimated by the above figures, and so have used the median British Columbia occupancy rate to calculate a population estimate for Leach's Storm-Petrels.

The range of lengths of burrows whose ends were reached was 0.3 - 1.5m. Unknowns were > 0.7m.

Using the median British Columbia occupancy rate of 91%, and the proportion of Fork-tailed Storm-Petrels determined in 1986, we calculated the nesting population of storm-petrels to be 16,999 pairs; 4,670 pairs of Fork-tailed and 12,329 pairs of Leach's Storm-Petrels.

Black Oystercatcher: In 1985, there were 3 pairs present on islet #10, and a single bird on islet #9. We searched for nests in 1986 and found the following:

	Emp	1E	2E	2Y	Total	Adults
Islet #10		1		1*	2	4
Islet #9	2				2	4
TOTAL	2	1		1	4	8

*This nest had 2 hatched eggshells in it. The young were not found, but the parents were excited. Nests were made of mussel, limpet and barnacle shells, and rock chips. Three were on rock and the other was a worn dirt bowl.

Glaucous-winged Gull: In 1985, we observed one adult chasing a Bald Eagle in the vicinity of islet #9. In 1986, there was one nest with 3 eggs on islet #10. The nest was made of grass. 2 adults were present.

Pigeon Guillemot: In 1985, there were 6 adults around the east side of Rock Islet. In 1986, we saw 2 adults fly out of crevices on islet #10. We found 1 empty nest containing an old broken egg.

Cassin's Auklet: Cassin's Auklets were nesting on all forested islets (#1-8) in association with storm-petrels. Burrow density was highest on the

perimeters. Burrows occurred throughout the vegetated areas of the smaller islets, but were absent from the central portion of the main islet, extending to a maximum of 50m from shore (Fig. EM260-1). Burrow entrances were located under roots and logs and into the open ground. Table EM260-4 lists burrow densities, colony areas, and total burrows found on each islet. Table EM260-1 lists burrows per plot along the transect on islet #1. The total area of burrowing was 2.5ha, and the total number of Cassin's Auklet burrows was calculated to be 6734.

Table EM260-4. Cassin's Auklet burrow density, colony area, and total burrows on Rock Islet and associated islets in 1985.

Islet	Burrows counted	Sampled area(m^2)	Density (burrows/m^2)	Colony area(m^2)	Total burrows
1	13	45	0.288 ± 0.125*	12,000	3,459 ± 1502
2	2	20	0.10	500	50
3	11	20	0.55	500	275
4	15	15	1.00	300	300
5	-	-	0.17**	890	151
6	23	150	0.15	150	23
7	23	135	0.17	8,000	1,364
8	25	60	0.41	2,670	1,112
Total				25,000	6,734 (6700)

* We could only calculate a standard error for the densities sampled along the line transect on islet #1:
** For islet #5, we used the density found on #7.

No occupancy rate was determined on Rock Islet. Using the median British Columbia occupancy rate of 75% we arrived at an estimate for the 1985 breeding population of 5100 pairs.

No burrow contents were determined in 1985. In 1986, one completely feathered CAAU chick was found in one burrow.

Predation: Little evidence of predation was recorded: 2 feather piles and 1 wing of Fork-tailed Storm-Petrel; 1 feather pile of Leach's Storm-Petrel; 1 pair of wings of Ancient Murrelet (under eagle nest); and 3 feather piles of Cassin's Auklet.

Associated species:

Bald Eagle - 2 nests: 1 on islet #7, 20m high in 30m spruce 30m from shore. One adult present on 10 June; and 1 nest on islet #1, 20m high in 35m spruce 10m from shore on the peak of the islet. Two adults perched nearby.

Northwestern Crow - 1 nest with 3 young found. 20+ adults.

Hair Seal - 4 in 1986

EM-270 SKINCUTTLE ISLAND 103 B/6

Location: In the Copper Islands at the east end of Skincuttle Inlet.

52°20'50"N 131°13'30"W.

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 27 April (exploration) and 4 May 1985 (transects), and 19 June 1986 (rock off south side).

Colony access: Cumbersome boat landing on south-west shore. Usable at medium tides, but difficult to leave boat at either high or low tides.

Base camp: We camped in the north-east bay on East Copper Island. Camping is feasible on the south-west side of Skincuttle Island, with the above access considerations. Water is not available.

Observers: 1985: M. Lemon, M. Rodway, D. Bertram, D. Powell.
1986: D. Garnier.

Census method: Line transects: 17 quadrats (7mx7m) were surveyed at 30m intervals along 3 parallel transects spaced 150m apart and run at a bearing of 2° (Fig. EM270-1).

Description: Skincuttle is a low, eroded limestone island with minimal slopes on a few small rises. It has a total area of 8.4ha, and rises to a maximum elevation of about 20m. The shore is rocky with extensive tidal reefs off the south and east sides. There are 7.1ha of forested habitat, most of which has an open mossy understory under spruce (up to 150cm dbh) and hemlock (up to 70cm dbh). Alder and crabapple are frequent, especially towards the east end, and scattered large cedar occur throughout the forest. Dense patches of young spruce (1-10m high) occur on the west and east ends, mixed with sporadic elderberry, huckleberry, salmonberry, and salal.

Nesting species:

Fork-tailed and Leach's Storm-Petrel: We found petrel burrows over much of the island (Fig. EM270-1). They were absent from interior areas towards the west and east ends (Table EM270-1). Burrows occurred mostly in open areas under tree roots, logs, and into open ground (Table EM270-2). One pair of each species were pulled from burrows on 4 May, but most burrows (7 of 9) explored were empty at this time.

Number of sample plots:	Higher density:	4
	Lower density:	5
	Overall:	9 (417m^2 - 0.9% of colony)
Average density:	Higher density:	1939 ± 729 burrows/ha
	Lower density:	204 ± 91 burrows/ha
	Overall:	975 ± 429 burrows/ha (Table EM270-3)
Colony area:	4.8 ha	
Total burrows:	4680 ± 2059	

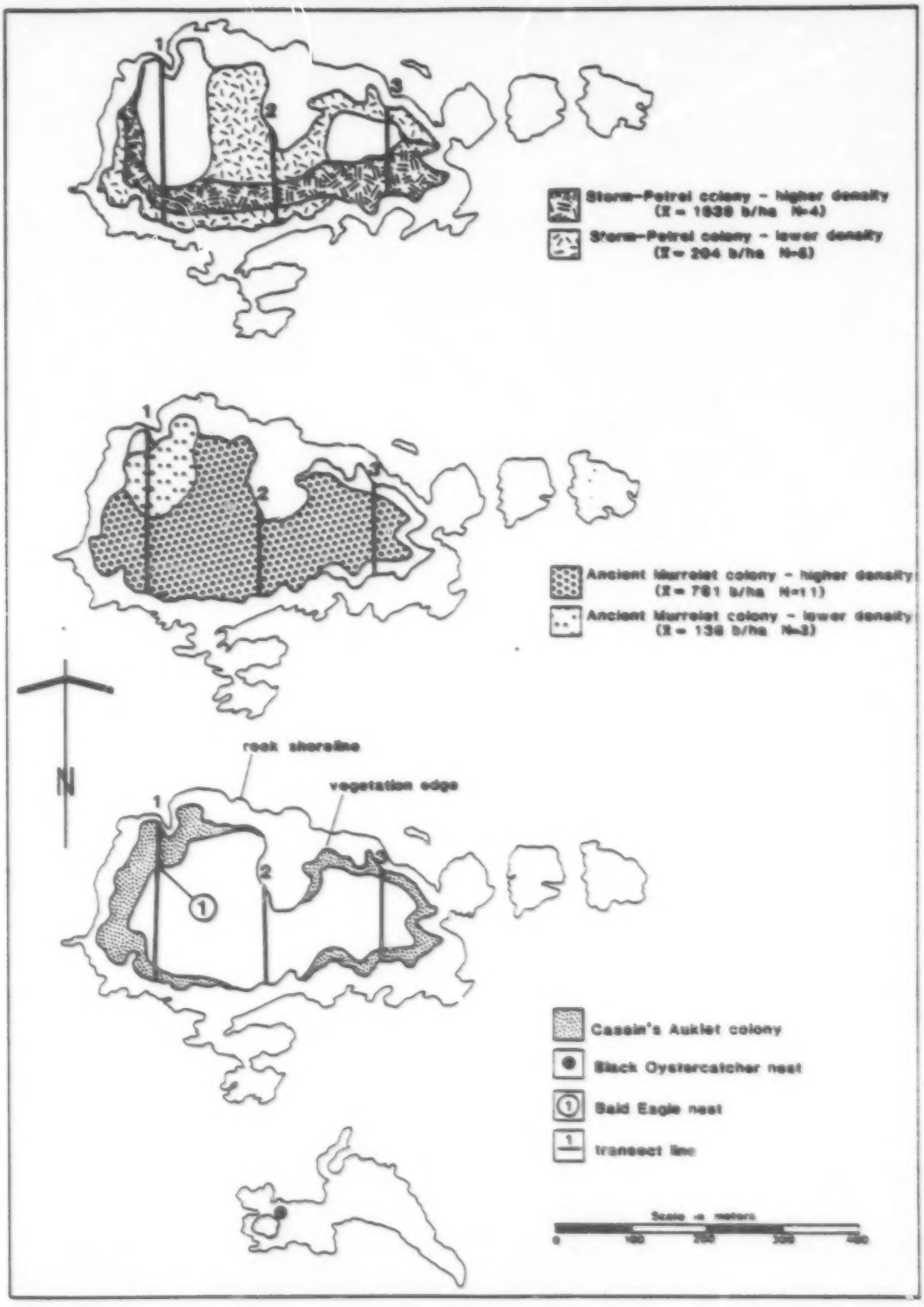

Figure EM270-1. Seabird colony areas and transect locations on Skincuttle Island in 1985.

Table EM270-1. Transect parameters and extent of Ancient Murrelet, Cassin's Auklet and Storm-Petrel colonies on Skincuttle Island in 1985.

Transect parameters								Extent of colony								
								Ancient Murrelet			Cassin's Auklet			Storm-Petrel		
Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)
1	2	217	1	7	9	5	0-10	0-190	0	68	0-15 165-217	0	28	0-45	0	35
2	2	121	2	3	5	3	0-6	0-121	0	34	-	-	-	0-121	0	34
3	182	124	1	1	3	3	2-4	15-105	15	47	0-15 105-124	0	19	0-15 75-124	0	39

Table EM270-2. Habitat locations of Ancient Murrelet, Cassin's Auklet and Storm-Petrel burrow entrances along transects on Skincuttle Island in 1985.

	ANMU burrows	%	CAAU burrows	%	Storm-Petrel burrows	%
Tree base	5	11.6			1	3
Live tree roots	14	32.6	3	20.0	11	33
Stump	2	4.6	3	20.0	3	9.1
Dead tree roots	6	13.9	1	6.7	2	6.1
Log	12	27.9	6	40.0	7	21.2
Open ground	1	2.3			1	3
Bank	3	7.0			6	18.2
Shrubbery			2	13.3	1	3
Driftwood					1	3
Totals	43		15		33	

Table EM270-3. Number of Storm-Petrel burrows in 7mx7m plots along transects on Skincuttle Island in 1985. Plots considered outside the colony are indicated by a dash. Bold print indicates plots within designated higher density area. * Plot 7mx3.5m.

Transect	Plot 1	2	3	4	5	6	7	8
1	2	**8**	-	-	-	-	-	-
2	0	5	0	2				
3	1	-	-	5	**10***			

Occupancy rate: Undetermined. Survey was too early in the breeding season, especially for Leach's Storm-Petrel.

1985 Nesting population: Using the median British Columbia occupancy rate of 91%, we estimated 4259 ± 1874 pairs of both species nesting.

Black Oystercatcher: On 10 June 1985 there was 1 nest with 1 egg. Two adults were attending a nest with 2 eggs on the south rock in 1986.

Ancient Murrelet: Ancient Murrelet burrows occurred in almost all the forested habitat, except for a narrow, 15m fringe on the east shore (Fig. EM270-1). In some interior areas burrowing was sparse but continuous (Table EM270-1).

Burrows were located under roots and logs, primarily in mossy areas, but we found some burrows under shrubs and spruce seedlings (Table EM270-2). All birds found in burrows were incubating 2 eggs (4 May). Mean length of 14 burrows whose ends were reached was 64 ± 5cm.

Number of sample plots	Higher density:	11
	Lower density:	3
	Overall:	14 (686m^2 - 1.1% of colony)
Average density:	Higher density:	761 ± 202 burrows/ha
	Lower density:	136 ± 136 burrows/ha
	Overall:	627 ± 174 burrows/ha (Table EM270-4)
Colony area:	6.1 ha	
Total burrows:	3822 ± 1061	
1985 Occupancy rate:	57.1 ± 21.0% (8 of 14 known; Table EM270-5)	
1985 Nesting population:	2182 ± 982 pairs	

Staging area: The staging area for all the Copper Islands was continuous off the south side of the islands in Skincuttle Inlet and extended east of the islands 8km into Hecate Straits (Fig. EM-2). On a boat run through this area on 15 May, from 1930hrs to 2040hrs, we counted 7100 Ancient Murrelets. Staging also extended around to the north of East Copper Island, but did not appear to continue north of George or any of the other Copper Islands.

Cassin's Auklet: We found Cassin's Auklet burrows around most of the perimeter of the island, except in the central area on the north and south sides (Fig. EM270-1). Most burrows were located in mossy areas within 30m of shore under logs, roots, and stumps, with a few occurring under shrubbery (Tables EM270-1 and EM270-2), and as far as 50m from the edge of vegetation. No birds were pulled from burrows.

Number of sample plots:	5 (221m^2 - 1.1% of colony)
Average density:	653 ± 253 burrows/ha (Table EM270-6)
Colony area:	2.0 ha
Total burrows:	1307 ± 507

Occupancy rate: A rate was not determined on Skincuttle Island.

1985 Nesting population: Using the median British Columbia occupancy rate of 75%, we estimated 980 ± 380 pairs.

Table EM270-4. Number of Ancient Murrelet burrows in 7mx7m plots along transects on Skincuttle Island in 1985. Plots considered outside the colony are indicated by a dash. Bold print indicates plots within designated higher density areas.

Transect	Plot 1	2	3	4	5	6	7	8
1	**2**	**4**	**5**	**12**	0	2	0	-
2	**2**	**2**	**1**	**3**				
3	-	**7**	**2**	**1**	-			

Table EM270-5. Occupancy of Ancient Murrelet burrows along transects on Skincuttle Island in 1985.

Transect	Plot	Empty	Adult and 2 eggs	Total occupied	Total known
1	1	1		0	1
1	2		2	2	2
1	3		1	1	1
1	4	1	2	2	3
1	6		1	1	1
3	2	4		0	4
3	3		2	2	2
Totals		6	8	8	14

Table EM270-6. Number of Cassin's Auklets burrows in 7mx7m plots along transects on Skincuttle Island in 1985. Plots considered outside the colony are indicated by a dash. *Plot 7mx3.5m.

Transect	Plot 1	2	3	4	5	6	7	8
1	2	-	-	-	-	-	1	8
2	-	-	-	-				
3	3	-	-	-	1*			

Predation: We encountered considerable signs of predation on Ancient Murrelets during our exploration of the island (48 feather piles, 4 single wings, 3 pairs of attached wings, and 13 depredated eggs). In our survey plots along the transects, we recorded 4 feather piles and 2 eggshells of Ancient Murrelet. From this we calculated that the average density of remains was 58 ± 25 feather piles/ha and 29 ± 20 eggshells/ha. This gives estimates of 355 ± 156 birds and 178 ± 121 eggs that had been preyed upon in the colony by the time of our survey.

We also found remains of Cassin's Auklets (1 feather pile, 1 single wing, and 1 eggshell), Storm-Petrels (2 feather piles), Herring Gulls (4 adult feather piles), Glaucous-winged Gulls (2 adult feather piles), and Black-legged Kittiwakes (1 adult feather pile). Bald Eagles were suspected to be the major predators on the island. One active nest was present (see below).

Associated species: (1985)

Double-crested Cormorant - 3 immatures on reef on 1 May

Pelagic Cormorants - 2 in breeding plumage on reef on 1 May

Black Oystercatcher - 1 on 27 April

Glaucous-winged Gull - 10 on reef on 18 May

Bald Eagle - 1 nest at NW corner: 50m high in 70m spruce, 40m from shore. One adult present. In addition, 12 eagles (2 adults, 5 immatures, and 5 subadults) were perched on the north-east corner of the island on 27 April.

Northwestern Crow - 4 nests found on 27 April (2 empty, 1 with 2 eggs, 1 unknown) in 5-10m tall spruce. Total population was estimated to be 20 birds.

Common Raven

Northern Sea Lion - 1 on 18 May

Hair Seal - 22 on reefs on 14 May

River Otter - runways

Sitka Deer - trails and droppings

Location: The middle island in the Copper Islands at the east end of Skincuttle Inlet. 52°21'N 131°12'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 27 April (exploration), 29 and 30 April 1985 (transects).

Colony access: Boat landing in the bay on the mid-north side. Rocky at low tide.

Base camp: We camped on E. Copper Island. Camping possible above landing bay on George Island. Seepage water usually present.

Observers: M. Lemon, M. Rodway, D. Bertram, D. Powell.

Census method: Line transects: 67 quadrats (7mx7m) surveyed at 30m intervals along 4 parallel transects run at a bearing of 215°, and spaced 150m apart. Permanent plots were established for Ancient Murrelets (Appendix II).

Description: George is the largest island in the Copper Islands with a total area of 42ha. The topography is undulating with higher ridges and some cliffs and rocky bluffs occurring on the south side, where the island rises to its maximum elevation of 30m (determined on our survey). There is an extensive low, wet area in the center of the island, as well as on the mid-east side in the draw that extends across the island from the large north bay.

George Island has 32.7ha of vegetated habitat. The forest is predominantly spruce (up to 180cm dbh) near shore changing to more hemlock (70-100cm dbh) and some redcedar in the interior. The trees are smaller on the south side (40-60cm dbh), and cedar is more abundant, as well as crabapple, many of which are dying. Salal used to be extensive along the south side, but much of it is now dead, and old stalks carpet the forest floor in some areas close to shore. Moss is the predominant ground cover thoughout the island, though much of the forest floor is bare litter. Large areas on the east side and the northwest corner are covered with dense spruce seedlings (0.5m high). There are narrow fringes of grass around some of the perimeter. Scattered windfalls occurred along the east and south-east shores, and there was a recent patch just west of the north bay.

Nesting species:

Ancient Murrelet: Ancient Murrelets were nesting over most of the island except for the wet areas in the center (Fig. EM280-1, Table EM280-1). Burrow density was low in the areas surrounding the central wet areas of the island, and highest on raised interior ridges. Most burrows were located in bare and mossy ground under roots, logs, tree bases, and stumps, with a few occurring under dense spruce seedlings (Table EM280-2). Mean length of 53 measured burrows was 60 $\pm$ 4cm. Most occupied burrows at this time contained adults incubating 2 eggs (81%, 35 of 43). There were single cold eggs in most of the rest, indicating that some birds were still laying (Table EM280-4).

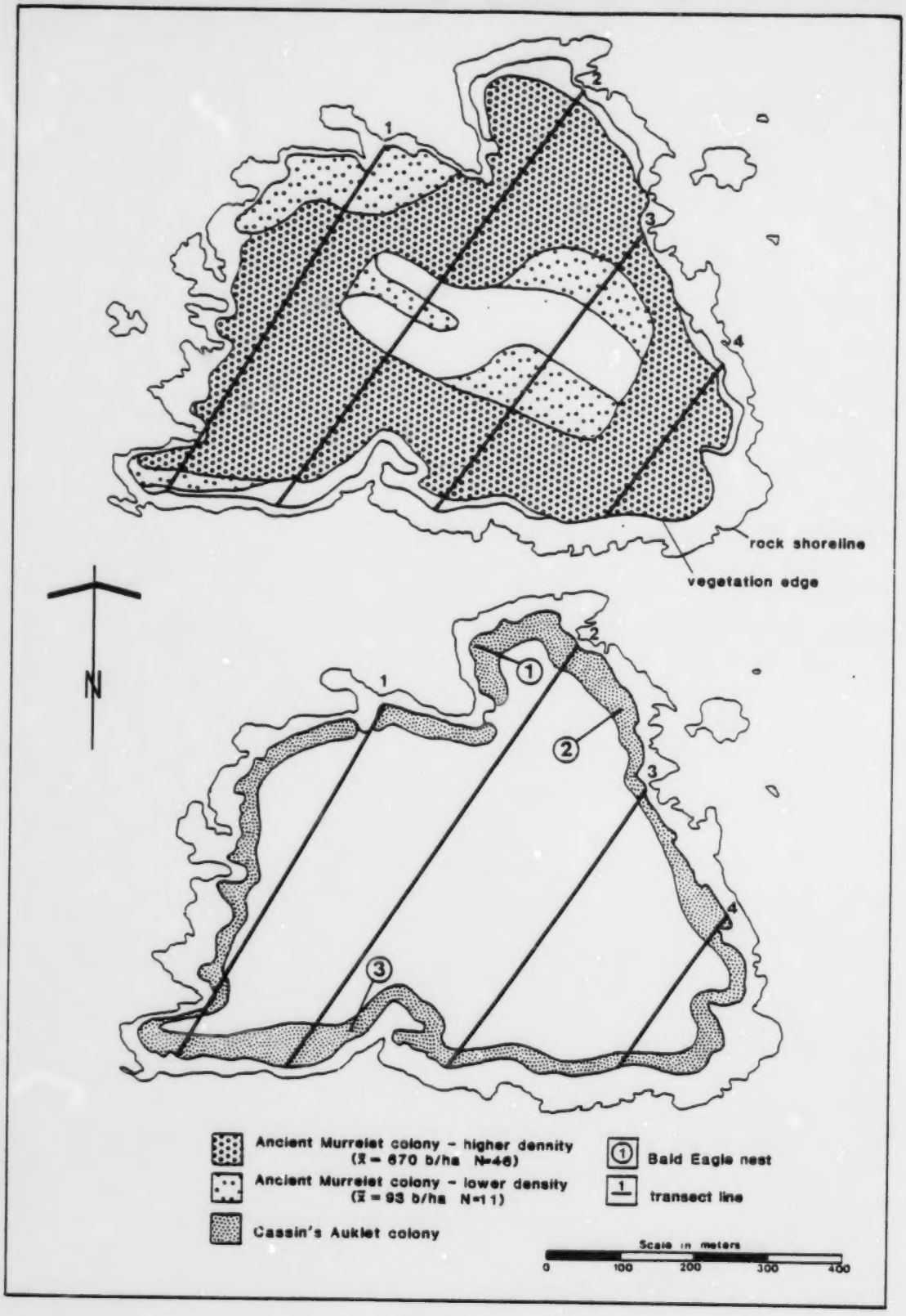

Figure EM280-1. Seabird colony areas and transect locations on George Island in 1985.

Table EI280-1. Transect parameters and extent of Ancient Murrelet and Cassin's Auklet colonies on George Island in 1985.

Transect parameters								Extent of colony						
								Ancient Murrelet				Cassin's Auklet		
			Elevation						Distance from nearest shore			Distance from nearest shore		
Transect	Bearing (°)	Total length (m)	Beg. (m)	End (m)	Max. (m)	Average slope (°)	Range of slope (°	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevation (m)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevations (m)
1	215	555	2	4	15	9	2-30	0-555	0	110	2-15	0-15 465-495 525-555	0	17	2-10
2	215	683	2	3	30	9	0-33	15-315 345-375 435-645	15	200	2-20	0-45 615-683	0	45	2-14
3	35	478	1	2	20	6	0-20	15-255 350-478	0	205	2-20	0-20	0	20	1-2
4	215	246	3	3	17	10	5-20	15-246	0	75		0-45 225-246	0	35	3-10

Table EM280-2. Habitat locations of Ancient Murrelet and Cassin's Auklet burrow entrances along transects on George Island in 1985.

Habitat locations	Ancient Murrelet		Cassin's Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	25	16.2	6	9.8
Live tree roots	44	28.6	18	29.5
Stump	26	16.9	4	6.6
Dead tree roots	16	10.4	2	3.3
Log	35	22.7	17	27.9
Rock	3	1.9	4	6.6
Open ground	2	1.3	6	9.8
Into bank	3	1.9	3	4.9
Dense herbs			1	1.6
Totals	154		61	

Number of sample plots: Higher density: 46
Lower density: 11
Overall: 57 (2793m^2 - 1.0% of colony)

Average density: Higher density: 670 ± 83 burrows/ha
Lower density: 93 ± 32 burrows/ha
Overall: 558 ± 74 burrows/ha (Table EM280-3)

Colony area: 27.1 ha

Total burrows: 15,122 ± 2005

1985 Occupancy rate: 76.8 ± 5.6% (43 of 56 known)

1985 Nesting population: 11,614 ± 1751 pairs

Staging area: See Skincuttle Island and Fig. EM-2.

Cassin's Auklet: We found Cassin's Auklet burrows around almost the entire perimeter of the island (Fig. EM280-1). Burrows extended up to 45m from shore (Table EM280-1), and most were located under tree roots and logs in open mossy or bare litter areas. Few occurred under the thick spruce seedlings (Table EM280-2). Burrowing was sparse in the smaller forest along the south shore. Birds found in burrows were incubating eggs at this time.

Number of sample plots: 11 (539m^2 - 0.8% of colony)

Average density: 1130 ± 290 burrows/ha (Table EM280-5)

Colony area: 7.0 ha

Total burrows: 7910 ± 2030

1985 Occupancy rate: 75 ± 7.2% (6 of 8 known; Table EM280-6)

1985 Nesting population: 5,933 ± 1619 pairs

Table EM280-3. Number of Ancient Murrelet burrows in 7mx7m plots along transects on George Island in 1985. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area..

Plot	Transect 1	2	3	4
1	0	-	-	-
2	1	4	**3**	4
3	1	**8**	1	**11**
4	0	5	0	**8**
5	**2**	1	0	**2**
6	**7**	0	4	**2**
7	**11**	1	1	5
8	**4**	6	0	1
9	**4**	1	1	1
10	**2**	4	-	
11	5	4	-	
12	**4**	-	-	
13	**0**	1	0	
14	**1**	-	0	
15	**3**	-	**3**	
16	**0**	3	**8**	
17	**4**	**2**		
18	**4**	**1**		
19	0	**2**		
20		**0**		
21		**4**		
22		**1**		
23		-		

Table EM280-4. Occupancy of Ancient Murrelet burrows along transects on George Island in 1985.

Date	Transect	Plot	Burrow contents						Total occup.	Total known
			Empty	1 cold egg	2 cold eggs	Adult+ 1 egg	Adult+ 2 eggs	Adult+ unk.		
29/04	1	3	1						0	1
29/04	1	5			1		1		2	2
29/04	1	6	1	1			2	1	4	5
29/04	1	7	2			1	7		8	10
29/04	1	8					4		4	4
29/04	1	9	1				2		2	3
30/04	1	10	1						0	1
30/04	1	11					1		1	1
30/04	1	12		1					1	1
30/04	1	15					1		1	1
30/04	1	18	1				2		2	3
29/04	2	3					3		3	3
29/04	2	4		1					1	1
29/04	2	10	1						0	1
29/04	2	11					1		1	1
29/04	2	19					1		1	1
29/04	2	21		1					1	1
29/04	2	22	1						0	1
30/04	3	2		1					1	1
30/04	3	3					1		1	1
30/04	3	6					3		3	3
30/04	3	16					1		1	1
30/04	4	3	1						0	1
30/04	4	4					1		1	1
30/04	4	5					1		1	1
30/04	4	7	3				2		2	5
30/04	4	8					1		1	1
Totals			13	5	1	1	35	1	43	56

Table EM280-5. Number of Cassin's Auklet burrows in 7mx7m plots along transects on George Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect 1	2	3	4
1	0	11	3	3
2	-	1	-	2
3-8	-	-	-	-
9	-	-	-	5
10-16	-	-	-	
17	2	-		
18	-	-		
19	8	-		
20		-		
21		-		
22		12		
23		13		

Table EM280-6. Occupancy of Cassin's Auklet burrows along transects on George Island in 1985.

Date	Transect	Plot	Empty	Adult*	Adult + 1 egg	Total occupied	Total known
30/04	1	19	1		2	2	3
29/04	2	22			1	1	1
29/04	2	23	1		2	2	3
30/04	3	1		1		1	1
Totals			2	1	5	6	8

* Only the adult was found in this burrow but an egg may have been present.

Predation: We saw substantial evidence of predation on Ancient Murrelets on our exploration of the island (144 feather piles, 5 pairs of attached wings, 4 single wings, and 52 eggshells). We calculated the density of remains in our survey plots to be 68 ± 16 feather piles/ha and 67 ± 18 eggshells/ha (Table EM280-7). This indicated that the amount of predation that had occurred up until the time of our survey was 1843 ± 445 birds and 1813 ± 482 eggs.

We found minimal signs of predation on Cassin's Auklets (1 feather pile and 4 eggshells), Fork-tailed Storm-Petrels (2 feather piles), Sooty Shearwater (1 feather pile and skull), and Herring Gull (1 feather pile).

We suspected that Bald Eagles were the major predators on the island. There were three active Bald Eagle nests, and we found 21 large pellets containing feathers during our survey. A few River Otter scats contained some feathers, but most were of fish.

Associated species: All sightings are on the days of our survey unless otherwise noted.

Fork-tailed Storm-Petrel - 2 feeding along south shore (No sign of nesting by petrels was found).

Pelagic Cormorant - 1

Black Oystercatcher - 6 on tidal reefs

Pigeon Guillemot - 1

Marbled Murrelet - 1

Bald Eagle - 3 active nests (Fig. EM280-1):

1. 40m high in 45m spruce, 5m from shore on north side.

2. 30m high in 40m spruce, 20m from shore on the east side.

3. 30m high in 40m spruce, 10m from shore in the south bay. An adult was sitting in nest #3, and adults were near the other two on 27 April. One immature and one subadult bird were perched on the south-east corner.

Northwestern Crow - 2 nests found: 1 with 4 eggs on 27 April and 4 young on 8 May; and 1 with 2 eggs on 8 May.

Common Raven - 3

Northern Sea Lion - 1 on 8 May

Hair Seal - 18

River Otter - Runways and scats

Sitka Deer - Trails and droppings

Table EM280-7. Depredated remains in 7mx7m plots along transects on George Island in 1985.

Transect	Plot	ANMU feather pile	ANMU wing	Depredated ANMU egg	CAAU feather pile	CAAU wing	BAEA pellet with feathers
1	7						1
1	9	1					2
1	10	2					1
1	11	1					
1	13			1			1
1	14			4			
2	2	1					
2	3	2		1			1
2	5			1			
2	9	2		1			
2	13						1
2	15	1		1			
2	16		1				
2	17			1			8
2	18	1		1			
2	19			1			
2	21			1			
2	22					1	1
3	2			1			
3	4	1					
3	5	1					
3	6			1			
3	7		1				
3	8	1					
3	13	1					
3	15	1		1			
3	16	2					3
4	1	1					
4	3			1			
4	4			1			
4	5	1					
4	6	1					
4	7			1			
4	8			1			
4	9				1		1
Totals		21	2	20	1	1	20

Location: Part of the Copper Islands at the east end of Skincuttle Inlet.

52°21'25"N 131°11'20"W

Land status: Crown Land: part of proposed South Moresby National Park; Provincial Ecological Reserve.

Date of visit: 12 May (exploration) and 18 May 1985 (transect).

Colony access: Drop-off from boat. In calm weather and higher tides, landing is possible on small beach on south-east side.

Base camp: Not suitable. We camped on East Copper I.

Observers: M. Lemon, D. Garnier.

Census method: Line transect: 9 quadrats (7mx7m) surveyed every 30m along 1 transect run at a bearing of 316° 269m across the island.

Description: Jeffrey is a 8.4ha island with steep rocky sides, rising to a maximum elevation of 25m (determined on our survey). It has 6.3ha of vegetated habitat. Young regenerating spruce (10-30cm dbh) cover considerable perimeter sections, especially on the north and east sides, and extend into interior areas in some places (Fig. EM290-1). The interior forest is mature spruce (60-80cm dbh) with some hemlock and Sitka Alder. Much of the ground under both the young and mature forest is bare litter with patches of moss occurring under the larger trees. There is a wet area in the interior towards the west end.

Nesting species:

Ancient Murrelet: Ancient Murrelets were nesting over most of the island except along parts of the perimeter and in the wet area towards the west end (Fig. EM290-1). Burrows were located under logs and tree roots (Table EM290-1). Of the three burrows whose contents were determined, 1 contained an adult and 2 eggs, 1 contained an adult and 2 young, and from the third the chicks had already left, just the freshly hatched egg membranes remained.

Number of sample plots: 7 (343m^2 - 0.9% of colony)

Average density: 408 ± 204 burrows/ha (Table EM290-2)

Colony area: 4.0 ha

Total burrows: 1632 ± 816

1985 Occupancy rate: The 3 burrows whose contents were determined were too few to give a valid occupancy rate.

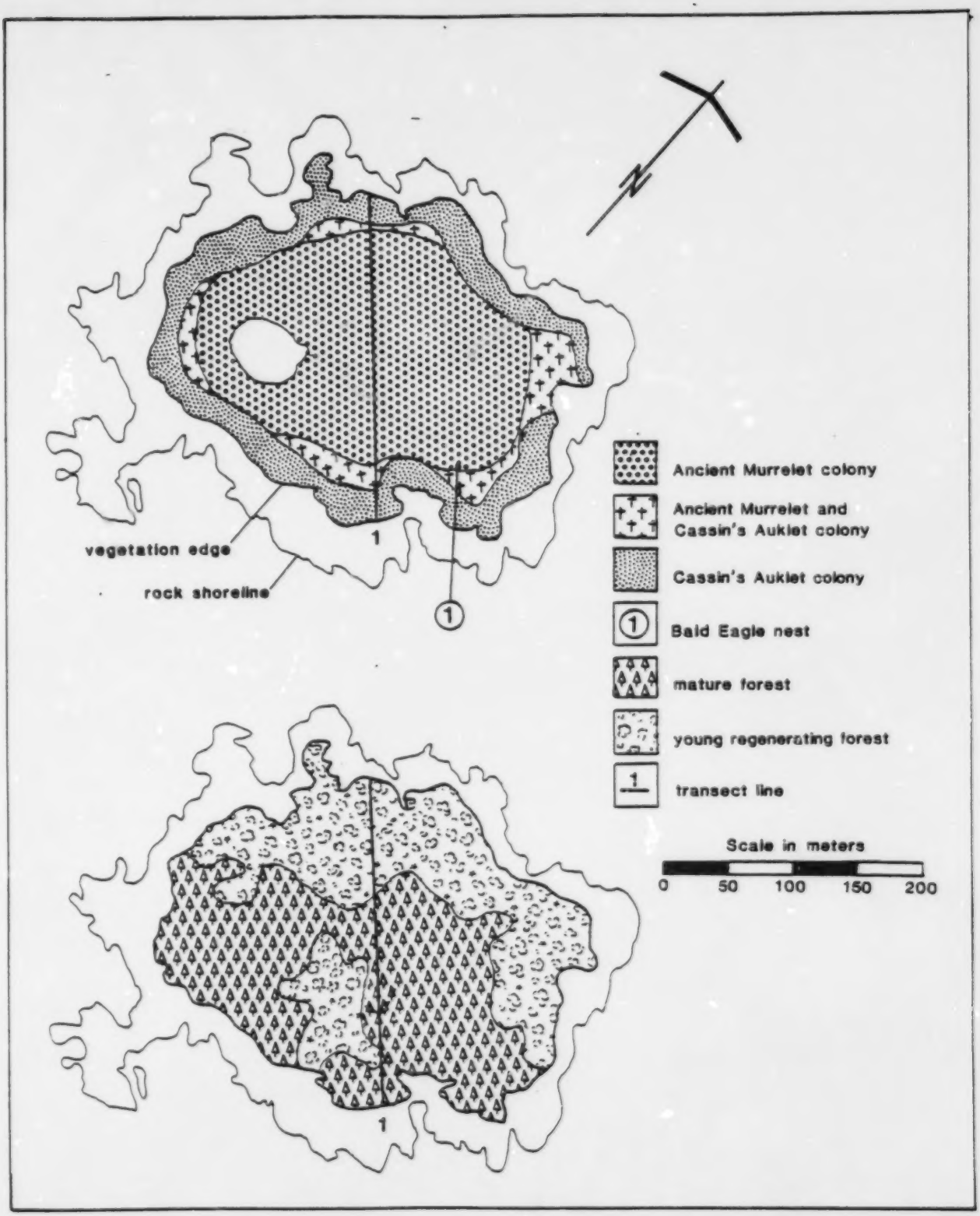

Figure EM290-1. Seabird colony areas, transect location and forest cover on Jeffrey Island in 1985.

Table EM290-1. Habitat locations of Ancient Murrelet and Cassin's Auklet burrow entrances along transect on Jeffrey Island in 1985.

Habitat location	Ancient Murrelet		Cassin's Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	1	7	-	
Live tree roots	3	21	6	27
Stump	1	7	-	-
Dead tree roots	-	-	1	5
Log	8	57	2	9
Rock	1	7	-	-
Open ground	-	-	6	27
Into bank	-	-	7	32
Totals	14		22	

1985 Nesting population: Using the median British Columbia occupancy rate of 63%, we estimated 1028 $\pm$ 514 pairs.

Staging area: See Skincuttle Island and Fig. EM-2.

Cassin's Auklet: Cassin Auklet burrows were located around the perimeter within 40m of shore in open ground and under tree roots (Fig. EM290-1 and Table EM290-1). Two known burrows contained adults incubating eggs and two others contained chicks, one still with a brooding adult (Table EM290-3).

Number of sample plots: 3 (147m^2 - 0.6% of colony)

Average density: 1497 $\pm$ 1192 burrows/ha (Table EM290-2)

Colony area: 2.5 ha

Total burrows: 3743 $\pm$ 2980

1985 Occupany rate: 71.4 $\pm$ 8.2% (5 of 7 known)

1985 Nesting population: 2673 $\pm$ 2136 pairs

Table EM290-2. Number of Ancient Murrelet and Cassin's Auklet burrows in 7mx7m plots along transect on Jeffrey Island in 1985. Plots considered outside the colony are indicated by a dash.

	Plot								
	1	2	3	4	5	6	7	8	9
Ancient Murrelet	-	6	0	0	5	0	3	0	-
Cassin's Auklet	19	1	-	-	-	-	-	-	2

Table EM290-3. Occupancy of Cassin's Auklet burrows along transect on Jeffrey Island in 1985.

Plot	Empty	Cold egg	Adult and egg	Adult and chick	Chick
1	2	1	1	1	1
9			1		

Table EM290-4. Depredated remains of Ancient Murrelets found in 7mx7m plots along transect on Jeffrey Island in 1985.

	Plot						
	2	3	4	5	6	7	Totals
Feather pile	2	1	-	2	-	1	6
Single wing	1	-	-	-	-	-	1
Pair of wings	1	1	-	-	-	-	2
Depredated egg	2	-	-	-	1	-	3

Predation: On our exploration we found considerable evidence of predation on Ancient Murrelets (38 feather piles, 3 pairs of attached wings, 1 single wing, and 21 eggshells), and some on Cassin's Auklets (3 feather piles, 3 pairs of attached wings, 2 single wings, 2 everted skins, and 6 eggshells). Ten Bald Eagle pellets containing feathers, and some River Otter scats with a few feathers were observed. The density of depredated remains of Ancient Murrelets was calculated from the transect records (Table EM290-4). The quantity of predation on the island estimated from this seems excessive, probably due to the small number of plots sampled (N=7). The estimates were 175 ± 69 feather piles and 87 ± 61 eggshells per hectare, or 700 ± 278 birds and 350 ± 243 eggs that had been preyed upon this season.

Associated species:

Bald Eagle - 1 nest: 30m high in 35m spruce (70cm dbh), 25m from shore of south bay. 2 adults present.

Black Oystercatcher - 2

Northwestern Crow - 4; 1 nest found.

River Otter - trails and scats

EM-300 EAST COPPER ISLAND 103 B/6

Location: At the east end of the Copper Islands at the east end of Skincuttle Inlet. 52°21'30"N 131°10'30"W

Land status: Crown Land: part of proposed South Moresby National Park; Provincial Ecological Reserve.

Date of visit: 24 April to 1 May, 3 to 19 May, and 8 to 12 June 1985 (base camp and night observations); 26 April and 12 May (exploration), 28 April, 6 and 11 May (transects).

Colony access: Sheltered boat landing in the bay on the north-west corner. Slimy boulders at low tide. The bay is long and narrow, allowing boats to be tied off between shores.

Base camp: Expansive meadow at the head of the landing bay provides ample camping space, though drainage is a problem in heavy rain. Seepage water is obtainable on the east side of the bay just south of the camping meadow. We got most of our water from Burnaby Island.

Observers: M. Lemon, M. Rodway, D. Bertram, D. Garnier, D. Powell, D. Power.

Census method: 42 quadrats (7mx7m) surveyed at 30m intervals along 4 parallel transects run at a bearing of 188° and spaced 200m apart. Permanent plots were established for Cassin's Auklets (Appendix II).

Description: East Copper is a 30.9ha island with a rocky shoreline and undulating knolls and ridges that rise to a maximum elevation of 30m (determined along transects). There are rock bluffs along the shore and some steep slopes on the edges of knolls and ridges, but most of the interior of the island has only moderate slopes. Behind the large bay on the north side is an extensive wet seepage area.

There are 24.7ha of forested habitat, with spruce the dominant tree around the perimeter, and hemlock and some redcedar more abundant in the interior. Extensive tracts of young, regenerating spruce (5 to 20cm dbh) occur at the east end and along the north and south sides. The trees in the mature forest range in size from 50 to 130cm dbh. Red Alder, Sitka Alder and crabapple occur along the edges. There is little understory in the interior, which is mostly bare litter with some moss. Grass grows on the fringes around the island, and through a valley on the mid-north side where there is a swath of old windfall. Towards the west end of the island is an open, grassy meadow situated between a narrow chute bay that enters from the northwest side and a wider rocky bay that opens to the south. This meadow is the site of past mineral exploration and is kept open by browsing deer. Remains of buildings and machinery are evident. We found a deep vertical shaft, and the ridge of tailings from it, on the hill west of this meadow. This shaft has been a death trap for many Ancient Murrelets. We covered the top of the shaft with heavy fish net to prevent birds falling in, and posted 'Danger' signs on the trees around it to alert human visitors.

East Copper Island along with Jeffrey and Rankine Islands was established as an Ecological Reserve on 29 May 1973.

Nesting species:

Storm-Petrel: We only found 4 storm-petrel burrows on East Copper Island. They were located 20-30m from shore mixed with Cassin's Auklet burrows on rocky knolls on the south side of the island (Fig. EM300-1). From 1 burrow, we pulled fresh nesting material (moss) and a Leach's Storm-Petrel feather. We heard individual birds of both Fork-tailed (8, 9 and 11 June at 2300hrs to 2430hrs) and Leach's (7, 8, 9, 14, 18 May, and 8 and 11 June at 2400hrs to 2430hrs) Storm-Petrels calling around the south side where the burrows were found. We suspect there were less than 50 pairs of storm-petrels nesting on East Copper in 1985 (20 pairs each of Fork-tailed and Leach's Storm-Petrels).

In 1977, BCPM surveyors found petrels nesting on the headlands along the north side. We found no evidence of nesting in that area in 1985.

Black Oystercatcher: Two pair were nesting: one nest with 3 eggs (18 May) at the east end made of rock chips on rock; and one nest with 1 egg (10 June) on the shore rock at the west end made of pieces of clam and Red Turban shells, and crab carapace and pincers.

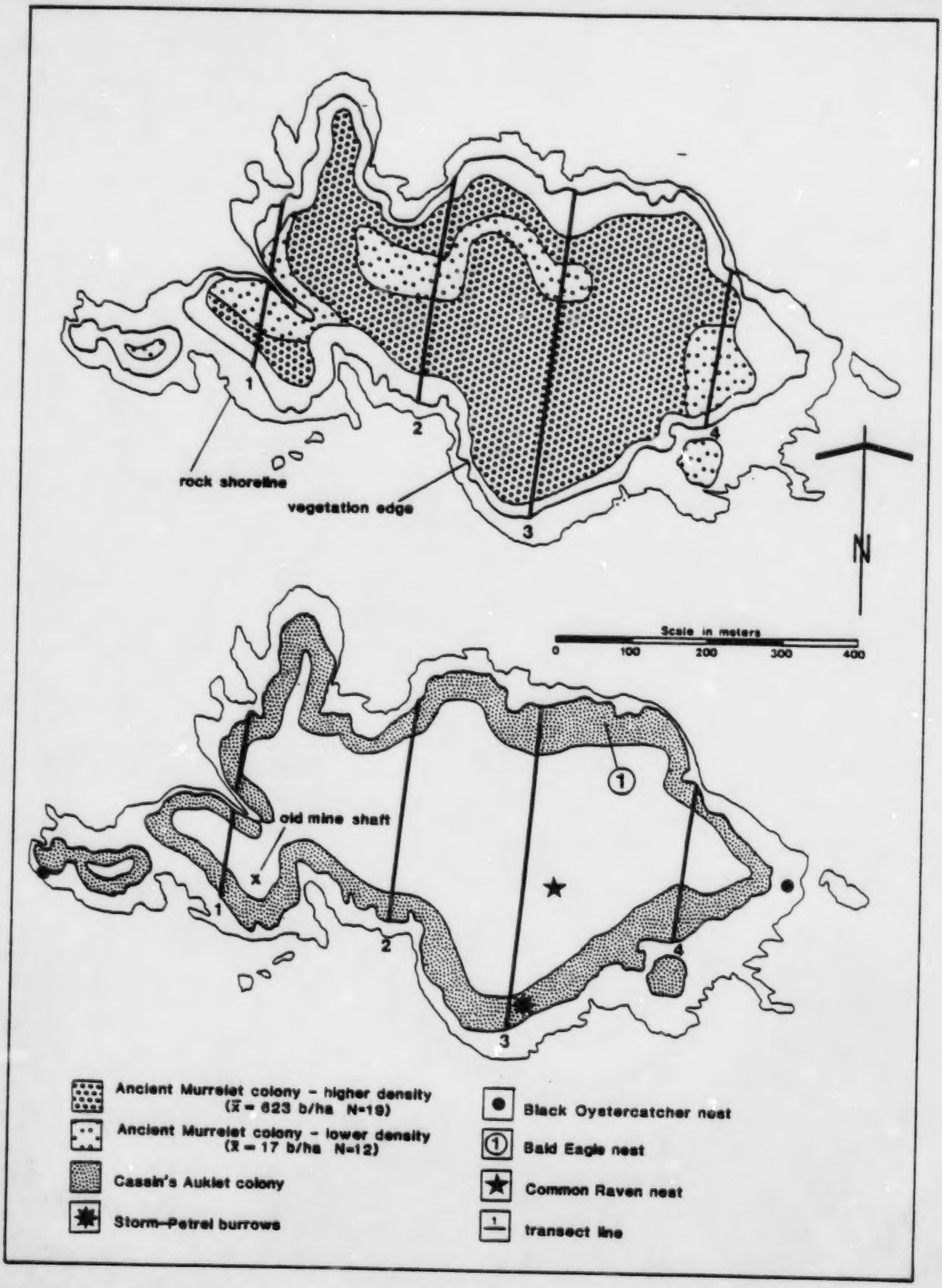

Figure EM300-1. Seabird colony areas and transect locations on East Copper Island in 1985.

Pigeon Guillemot: A maximum of 30 birds were sighted around the east end of the island on 18 May. We did not search for nests, but suspected that nesting occurred later in the season.

Ancient Murrelet: Ancient Murrelets were burrowing over most of the island except the perimeter areas and the area under the regenerating spruce on the east end (Fig. EM300-1). Burrows usually began within 30m of the edge of the vegetation (Table EM300-1). Most burrows were located under live tree roots, logs and stumps (Table EM300-2). The mean length of 18 burrows whose ends were reached was 50 ± 6cm. The density of burrowing was highest in the middle of the widest portion of the island. Of the 12 occupied burrows explored, 75% contained adults incubating 2 eggs (Table EM300-4). The first chick was heard on 12 May (see nocturnal activity).

Number of sample plots:	Higher density:	19
	Lower density:	12
	Overall:	31 (1519m^2 - 0.9% of colony)
Average density:	Higher density:	623 ± 103 burrows/ha
	Lower density:	17 ± 17 burrows/ha
	Overall:	388 ± 83 burrows/ha (Table EM300-3)
Colony area:	17.8 ha	
Total burrows:	6907 ± 1477	
1985 Occupancy rate:	63.2 ± 10.5% (12 of 19 known)	
1985 Nesting population:	4365 ± 1170 pairs	

Staging area: See Skincuttle Island and Fig. EM-2.

Cassin's Auklet: We found Cassin's Auklet burrows around most of the perimeter of the island. They extended from 30m to 70m inland from the edge of the vegetation (Fig. EM300-1; Table EM300-1). Burrow density was generally highest along the south side of the island (Table EM300-5). Burrows were located under tree roots, logs, stumps, or into the open ground and banks (Table EM300-2). The mean length of 27 burrows whose ends were reached was 97 ± 7cm. Of 25 burrows whose contents were determined, 14 contained incubating adults (28 April and 6 May), and 9 contained adults with young chicks (6 May). In 2 burrows we were unable to reach further than the adult (Table EM300-6).

Number of sample plots:	17 (833m^2 - 0.9% of colony)
Average density:	1404 ± 312 burrows/ha
Colony area:	9.3 ha
Total burrows:	13,057 ± 2902
1985 Occupancy rate:	83.3 ± 7.2 % (25 of 30 known)
1985 Nesting population:	10,876 ± 2585 pairs.

Table EH300-1. Transect parameters and extent of Ancient Murrelet and Cassin's Auklet colonies on East Copper Island in 1985.

Transect parameters								Extent of colony						
								Ancient Murrelet				Cassin's Auklet		
			Elevation						Distance from nearest shore				Distance from nearest shore		
Transect	Bearing (°)	Total length (m)	Beg. (m)	End (m)	Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevation (m)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevations (m)
1	188	228	4	3	12	10	4-19	45-195	0	50	4-12	0-105 195-228	0	20	3-7
2	188	309	3	5	25	11	2-30	15-270	10	122	4-25	0-45 270-309	0	39	3-15
3	8	440	5	6	30	16	6-36	15-375	15	170	10-30	0-45 375-440	0	65	5-17
4	8	217	3	4	18	6	0-20	15-195	15	90	4-18	0-75 195-217	0	70	3-11

Table EM300-2. Habitat locations of Ancient Murrelet and Cassin's Auklet burrow entrances along transects on East Copper Island in 1985.

Burrow location	Ancient Murrelet		Cassin's Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	5	8.5	13	11.1
Live tree roots	25	42.4	25	21.4
Stump	7	11.9	16	13.7
Dead tree roots	2	3.4	8	6.8
Log	16	27.1	22	18.8
Rock	2	3.4	6	5.1
Grass tussock			1	0.9
Open ground			13	11.1
Into bank	2	3.4	13	11.1
Totals	59		117	

Table EM300-3. Number of Ancient Murrelet burrows in 7mx7m plots along transects on East Copper Island in 1985. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Plot	Transect 1	2	3	4
1	-	-	-	-
2	-	5	1	0
3	0	1	4	0
4	1	2	3	0
5	0	0	4	0
6	0	0	9	1
7	5	0	6	4
8	-	2	1	-
9		2	2	
10		-	4	
11		-	0	
12			0	
13			2	
14			-	
15			-	

Table EM300-4. Occupancy of Ancient Murrelet burrows along transects on East Copper Island in 1985.

Date	Transect	Plot	Burrow contents: Empty	1 cold egg	2 cold eggs	adult + 2 eggs	Total occupied	Total known
28/04	1	4	1				0	1
06/05	1	7	1			2	2	3
28/04	2	3	1				0	1
28/04	2	4				1	1	1
06/05	2	8			1		1	1
06/05	2	9		1			1	1
06/05	3	4	1				0	1
06/05	3	5				1	1	1
11/05	3	6	1			1	1	2
11/05	3	7	1			1	1	2
11/05	3	9	1				0	1
11/05	3	10		1		2	3	3
11/05	3	13				1	1	1
Totals			7	2	1	9	12	19

Table EM300-5. Number of Cassin's Auklet burrows in 7mx7m plots along transects on East Copper Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect 1	2	3	4
1	11	18	16	6
2	4	1	8	2
3	1	-	-	0
4	5	-	-	-
5	-	-	-	-
6	-	-	-	-
7	-	-	-	-
8	3	-	-	3
9		-	-	
10		10	-	
11		21	-	
12			-	
13			-	
14			4	
15			4	

Table EM300-6. Occupancy of Cassin's Auklet burrows along transects on East Copper Island in 1985.

Date	Transect	Plot	Contents: Empty	Adult	Adult + egg	Adult + chick	Total Occupied	Total Known
28/04	1	1	1		3		3	4
28/04	1	2	1		1		1	2
28/04	1	4			1		1	1
6/05	1	8				2	2	2
28/04	2	1		1	3		4	4
6/05	2	10	1		1		1	2
6/05	2	11			4	4	8	8
6/05	3	1	1		1	2	3	4
6/05	3	2				1	1	1
6/05	4	1		1			1	1
6/05	4	8	1				0	1
	Totals		5	2	14	9	25	30

Staging area: Cassin's Auklets are not reported to stage around their colonies. On 15 May at 1900-2040hrs, we observed a group of 420 birds on the water 6-8km east of the island. This is the largest gathering of Cassin's Auklets we have seen near any colony.

Predation: We recorded a low rate of predation on Ancient Murrelets in our surveyed plots (5 feather piles and 8 depredated eggshells) (Table EM300-7). From these figures we calculated mean densities of 33 $\pm$ 14 feather piles/ha and 53 $\pm$ 19 eggshells/ha. This indicated a total amount of predation on the colony at the time of our transects of 587 $\pm$ 244 adults and 940 $\pm$ 336 eggs.

The only evidence of predation on Cassin's Auklets recorded was 6 depredated eggshells. We also found remains of Sooty Shearwaters (2 pairs of attached wings), Fork-tailed Storm-Petrel (1 feather pile), Herring Gull (1 feather pile), Glaucous-winged Gull (2 feather piles), and Black-legged Kittiwake (1 feather pile).

We suspected Bald Eagles were the major predators on the island (15 pellets of feathers were found, and signs of eagle were noted around some of the feather piles). There was one active nest (see below). Common Ravens were also nesting on the island. Many raven pellets found near their nest contained Ancient Murrelet feathers, and one contained the remains of an Ancient Murrelet chick. A Peregrine Falcon was occassionally sighted around the island.

Table EM300-7. Depredated remains in 7mx7m plots along transects on East Copper Island in 1985.

Tran	Plot	ANMU feather pile	Depredated ANMU egg	CAAU feather pile	Depredated CAAU egg	BAEA pellet with feathers
1	1					1
1	3		1			2
1	4				1	
1	6			1		
2	2	1				
2	4		1			
2	8		1			
3	4	1				
3	5					3
3	7		1			
3	8	1	1			1
3	9		2			1
3	10					2
3	11	1				
3	12					4
3	13		1			
4	6	1				
Totals		5	8	1	1	14

Nocturnal activity: Table EM300-8 lists the nocturnal activity of Ancient Murrelets and Cassin's Auklets recorded during our stay on East Copper Island.

Associated species:

Sooty Shearwater - 10,000 on 15 May, 8-10km east of island.

Fork-tailed Storm-Petrel - 2 on 15 May

Double-crested Cormorant - 1 on 15 May

Pelagic Cormorant - 2 on 11 May

Glaucous-winged Gull - 600 on 8 May

Rhinoceros Auklet - 57 east of the island on 15 May

Bald Eagle - 1 nest on north side , 30m high in 50m spruce, 20m from shore. 1 adult present on 26 April.
- 59 flying and perched on reefs on north side on 7 May.

Peregrine Falcon - flying

Table EM300-8. Nocturnal activity of seabirds recorded on East Copper Island in 1985.

DATE	TIME	CALLS	ARRIVALS	COMMENTS	WEATHER
24/04	2220-2230	48 - ANMU 22 - CAAU	24	from beach 1st CAAU at 2120	clear night
25/04			none heard		very stormy night
26/04	2230-2240 2240-2250	5 - CAAU 13 - ANMU	17 12	CAAU chorus at 0200	day - storms evening-clear then rain
27/04	2345-2400	16 - ANMU 3+- CAAU	11	quiet night	clear and 1/2 moon, some rain
28/04	2415-2430	0	2		some violent rain, come clear
29/04	2400	0	0	some heard in forest	SE gale
30/04	2300	1 - ANMU more CAAU		0300 - chorusing of ANMU and CAAU	stormy during day calmer at night
No observations 1-3 May					
4/05	2425-2440	4 - ANMU 2 - CAAU	7	count from tent	day - SW wind, occasionally cloudy - moon full
5/05	2444-2459	94 - ANMU	2	very active, tent flapping in wind-can't hear birds fly in.	evening - strong NW wind, moon in and out of clouds
6/05	2428-2443	306 - ANMU continuous chorus of CAAU	33	more active than 5 May, can hear easily from tent	day-clear, strong SW wind, night-cloudy, calm dark
7/05	2435-2450	407 - ANMU CAAU-continuous chorus 1 LSPE - 3 calls	29+		day-calm overcast, night-no wind, no moon, cloudy
8/05	2417-2432	398 - ANMU CAAU-continuous chorus 1 LSPE - 4 calls	29+	just about as busy as 7 May	wind and sea calm, partial overcast, no moon yet

Table EM300-8 (continued)

DATE	TIME	CALLS	ARRIVALS	COMMENTS	WEATHER
9/05	2412-2427	160 - ANMU CAAU-smaller chorus; 1 LSPE	2	quieter night for both ANMU and CAAU	day-blustery, some rain night-NW wind, clear early, but some wind and rain later
10/05	2405-2420	397 - ANMU 1 - CAAU	25	no CAAU chorus at this time	day-strong NW wind, clear night-clear, calmer
11/05	2322-2337	4 - ANMU 8 - CAAU	1	rained for 5min. of listening time	day-overcast, rain, storm-force SW, night-blowing
12/05	2415-2430	4 - ANMU 4 - CAAU		1 ANMU chick heard	day-SW storm, heavy rain, night-same
13/05	2350-2405	223 - ANMU 3 - CAAU -continuous	35	much more active than previous 2 nights	day-SW storm dies, switch to NW, night-calm, clear
14/05	2415-2430	407 - ANMU CAAU-medium chorus; 1 LSPE	8+	CAAU chorus very loud at 0300, 1 pair of ANMU chicks during time	day-overcast, moderate to strong SW, night - windy
15/05	no counts tonight			active night, CAAU chorus loud at 0300	day-calm and sunny, night-clear
16/05	2410-2425	308 - ANMU some CAAU	2	2 sets of ANMU chicks, 4 sets at 2300	day-clear, strong night-calm, clear, no moon
17/05	2415-2430	295 - ANMU CAAU - a few		4 or 6 sets of ANMU chicks	day-bright, clear, fresh NE, night-breezy
18/05	2345-2400	396 - ANMU CAAU calling LSPE calling	18+	4 or 6 sets of ANMU chicks. no chorus yet	day-clear, some NE night-calm, clear

Saw-whet Owl

Northwestern Crow - 7 nests found, 20 pairs

Common Raven - 1 active nest with an unused nest nearby.

Three fledged young seen on 9 June.

Hair Seal - 20 on reef on 16 May

River Otter

Sitka Deer

EM-310 HOWAY ISLAND 103 B/6

Location: East side of Burnaby Island off Poole Inlet.

52°23'30"N 131°15'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 5 May 1985 (1500-1930hrs) and 19 June 1986 (1510-1525hrs).

Colony access: We dropped crews off to survey the island, but landing was possible on the south side and west end beaches.

Base camp: Not suitable.

Observers: 1985: D. Bertram, D. Powell. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration and partial count. Only the east half of the island was searched in 1985. The occurrence of burrows on the west half was extrapolated from those observed in the similar habitat on the east end. In 1986, we surveyed the area around the cliffs on the south side where the gulls were nesting.

Description: Howay has a total area of 25ha with 20ha of vegetated habitat. It is a long, narrow island with dissected cliffs and steep slopes towards the east end, and more moderate, uniform slopes towards the west end. It rises to a maximum elevation of 89m. There are small valleys between separate cliff-faced knobs. Most of the island is covered with dense salal under spruce, hemlock and redcedar. There are some open areas within the salal, and patches of sword fern (Polystichum munitum) and Maianthemum occur in the valleys and on lower slopes. Salmonberry and twinberry occur along the edges of the salal.

Nesting species:

Fork-tailed Storm-Petrels: Four burrows were found on the slope of twinberry, salmonberry and sword fern behind the large cliff-rimmed knob on the south side at the east end. No other petrel burrows were found and we estimated that there were no more than 10 on the island. Petrel burrows under the thick shrubs would be difficult to find. Identification of species was based on depredated wings that were found in the area.

Pelagic Cormorant: In 1985, 37 in breeding plumage and 45 immatures were roosting on the rock bluffs on the south side at 1945hrs. We suspected they nested later in the season. No cormorants were present in 1986.

Black Oystercatcher: In 1985, 2 pairs were on the rocks on the south side. We did not search for nests.

Glaucous-winged Gull: In 1985, 17 adults were standing on territory on the south side cliffs. In 1986, we made the following records:

Empty	3E	Adults	Total nests (Estimated)
1	3	20	10

Only 4 nests were accessible on the cliffs. Gulls were sitting on nests on higher ledges. Nests were made of grass.

Pigeon Guillemot: In 1985, 6 birds were seen along the rocks on the north and south side. In 1986, 2 adults flew out of nest sites at the top of the cliff above the arch on the south side.

Ancient Murrelet: 500 burrows were estimated for the whole island (220 were estimated in the area explored at the east end). Burrows were located on the north and south sides in open patches higher on the slopes and along the edges of the cliffs and the shore. A cold egg was found in one burrow and depredated eggshells and feathers were seen (see predation). We estimated 300 pairs nesting.

Cassin's Auklet: 350 burrows were estimated for the island (135 were estimated in the area searched at the east end). Burrows were located along the edges near shore and at the top of the cliffs along the south side and the north end. We estimated 260 pairs nesting, which we would round to 250 pairs.

Predation: We found signs of predation on Fork-tailed Storm-Petrels (2 pairs of wings and 2 single wings), Ancient Murrelets (4 inverted carcasses, 6 attached pairs of wings, 1 single wing and 6 depredated eggshells) and Cassin's Auklets (2 feather piles). We suspect most predation was by Peregrine Falcons.

Associated species:

1985:Peregrine Falcon

Northwestern Crow

River Otter - runs.

There was no sign of deer on the island.

1986:Pelagic Cormorant - 12 immature

Peregrine Falcon - male, female, and young flying

Bald Eagle - 1 adult

EH-320 "ISLAND BAY GROUP" 103 B/6

Location: Unnamed group of islands at the mouth of Island Bay.

52°22'N 131°22'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (1945-1950hrs).

Colony access: Landing on many islands. Drop-off from boat on nesting rock.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: We boated around these islands and explored where we saw birds.

Description: Most of these small islands are forested with a predominantly salal understory. There are a few bare and grassy rocks.

Nesting species:

The only seabirds observed were on the small, grassy, 2.5m high rock in the middle of this group.

Black Oystercatcher: We found 3 empty scrapes of rock chips and a few shells. There were 2 adults present and we suspected only one pair nesting.

Pigeon Guillemot: 2 adults flying in the area.

EM-330 "KAT" ROCKS 103 B/6

Location: North of Kat Island in Burnaby Strait, north of Island Bay.

52°23'42"N 131°23'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (2000-2026hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count. We also boated around Kat Island but saw no sign of seabirds.

Description: "Kat" Rocks are two, low, grassy rocks, mostly Elymus and Angelica, with two small crabapple trees on the southern one.

Nesting species:

Black Oystercatcher:

	Emp	1E	2E	3E	Total
S rock	1		1	2	4
N rock	2	1	2		5
TOTAL	3	1	3	2	9

Nests were made of rock chips and shells. Two were on worn dirt bowls in the grass, the rest were on rock.

Glaucous-winged Gull:

	Emp	3E	Total	Adults
S rock	1	1	2	2
N rock		4	4	3
TOTAL	1	5	6	5

Nests made of grass in grass.

Pigeon Guillemot:

	Emp	1E	2E	Adults
S rock	7	1	2	21
N rock				7
TOTAL	7	1	2	28

Nest sites were under rocks. We found three depredated eggshells. Empty nests were obvious worn spots under rocks, sometimes with eggshell fragments.

Associated species:

Northwestern Crow - 2 empty nests on the ground against a rock and amongst the vegetation. Made of sticks lined with grass and moss.

EM-340 CENTRE ISLET 103 B/6

Location: Off the east side of Wanderer Island in Burnaby Strait.

52°25'05"N 131°23'40"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Exploration.

Description: This 1.7ha islet is covered with dense 1-2m salal under a redcedar, spruce and hemlock forest. Some crabapple and alder occur near shore, and there are open mossy areas at the north end.

Nesting species:

Pigeon Guillemot: 10-15 burrows were found along the east side. 3 birds flushed from nests. Total of 10 adults present.

Associated species:

Northwestern Crow

River Otter - lots of sign

Racoon - presence suspected from scats

EM-350 WANDERER ISLAND 103 B/6

Location: Off the mouth of Skaat Harbour at the north end of Burnaby Strait.

52°25'N 131°24'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 21 April 1985 (main survey) and 19 June 1986, 2045hrs.

Colony access: Landing on various beaches.

Observers: 1985: D. Bertram, D. Powell. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration. In 1986, we only boated by the island.

Description: Wanderer Island has a total area of 87ha. The west side of the island is steep with sections of exposed rock throughout the slope. The east side has a flat area along the shore and then rises steeply to a plateau-like area with extensive bogs. The north and south ends are flatter with raised knobs along the shore. Redcedar is the dominant tree with some hemlock and spruce. Pine and alder occur along the edges. On the east side the cedar is stunted, while on the south end there are large cedar and hemlock. The north end has been logged but many fallen or windblown trees remain. The understory is mostly salal with patches of moss.

Nesting species:

Black Oystercatcher: In 1986, 2 were flying around the rock at northwest corner.

Pigeon Guillemot: In 1986, we counted 35 in the bay at the north end.

No sign of burrowing by seabirds was found in 1985.

Associated species:

Bald Eagle

Common Raven

River Otter

Sitka Deer

Racoon - Suspected from scats seen on both sides of the island.

EM-360 SELS ISLET 103 B/6

Location: Off the west side of Wanderer Island at the north end of Burnaby Strait. 52°25'28"N 131°24'40"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 June 1986 (Main island) and 19 June 1986, 2035-2040hrs (Rocks at north end).

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes (Main island); M. Rodway, D. Garnier, D. Grinnell (Rocks at north end).

Census method: Exploration (main islet) and total count (north rocks).

Description: This 1.7ha islet is about two-thirds covered with salal and one-third more open ground, under a forest of spruce, redcedar and hemlock. Rocks at the north end are bare.

Nesting species:

Storm-Petrel: No sign of storm-petrels were found.

Black Oystercatcher: We found the following nests on the north rocks:

Emp	1E	1Y	Total	Adults
3	1	1	5	4

Nests were made of rock chips and shells.

Pigeon Guillemot: 40 adults counted around the islet.

Predation: We found feather piles of Glaucous-winged Gull and Northwestern Crow. Two 10cm sandlance were found 10m from the edge of the vegetation.

Associated species:

Northwestern Crow - 2 empty nests on the ground on the main island.

Hair Seal - 10 on north rocks

River Otter - den, scats

Racoon - presence suspected from scats.

EM-370 PARK ISLAND 103 B/6

Location: At the north end of Burnaby Strait, west of Huxley Island.

52°26'10"N 131°24'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 17 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Exploration.

Description: This 4.6ha island is covered with a mix of salal and open ground, under redcedar, spruce and hemlock. There was an extensive blowdown near the south end.

Nesting species:

Storm-Petrel: No sign of active burrows. Two possible old burrows were seen on the southeast corner. We found 1 Fork-tailed Storm-Petrel feather pile.

Black Oystercatcher: We sighted 2 chasing a Common Raven from the south beach rock.

Pigeon Guillemot: There were 25 gathered around the north end, where 1 flew from a rock face; and 2 off the west side, for a total of 27 birds around the island.

Associated species:

Common Raven - 4 - Suspect 2 adults and 2 immatures.

River Otter - den, runs, scats and abalone shells.

A few burrows were found that contained large (1cm) rodent droppings.

EM-380 KOGA ISLET 103 B/6

Location: At the north end of Burnaby Strait, south of Huxley Island.

52°25'45"N 131°22'40"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 2 May 1985 (0900hrs) and 17 June 1986.

Colony access: Drop-off from boat.

Observers: 1985: M. Rodway. 1986: D. Powell, H. Hay, N. Holmes.

Census method: We only went around the islet in the boat.

Description: This 1.1ha island is covered with dense salal under redcedar, hemlock and spruce, with an extensive blowdown along the west and north sides.

Nesting species:

Pigeon Guillemot: In 1985, 30 birds were counted along the shore on the west side. In 1986, we counted 36 around the island; all but 2 along the east side. 16 of these birds flew from sites on shore.

Associated species: (1986)

Bald Eagle - 1 adult

River Otter - runs

EM-390 NAKONS ISLET 103 B/6

Location: Off the north-west corner of Burnaby Island, between Burnaby and Huxley Islands. 52°26'N 131°21'06"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 22 April 1985 (1400-1500hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway.

Census method: Exploration.

Description: This small, 1.1ha, low islet has open mossy knobs under spruce, with grass on the edges. A number of the large spruce have recently blown over.

Nesting species:

Black Oystercatcher: 1 pair: 1 adult siting on an empty scrape of shells and rock chips.

No other evidence of use by seabirds was found.

Associated species:

Bald Eagle

Northwestern Crow - 5 nests: 4 empty and 1 with 5 eggs. Nests were in sheltered cavities in upturned roots of recently fallen spruce trees, and were made of sticks, grass, moss and cedar bark.

EM-400 ALDER ISLAND 103 B/6

Including the islet off the north end.

Location: North end of Burnaby Island east of Huxley Island.

52°27'N 131°19'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 16 and 17 April (Arrival and set up of camp), 18-21 April (Exploration and transects), 22 April (Islet off north end), and 23 April 1985 (Occupancy plot).

Colony access: Landing on beaches on south and north end of main island. Drop-off on small north islet.

Base camp: Good campsite at south end.

Observers: M. Lemon, M. Rodway, D. Bertram, D. Powell.

Census method: Line transects: On the main island, 87 quadrats (7mx7m), 30m apart, were surveyed along 6 parallel transects spaced 200m apart and run at a bearing of 252°. One transect with 3 quadrats (7mx7m) was run at 95° on the west section of the north islet. The higher eastern section of the north

islet was total counted. We did not attempt to determine burrow occupancy along transects as the survey occurred early in the Ancient Murrelet nesting season. On the last day of our visit to Alder Island, 23 April, we determined occupancy for both Ancient Murrelets and Cassin's Auklets in a separate plot located at the head and the north side of the cliff-bound bay on the east side of the island, just south of transect #4.

Description: Alder Island has a total area of 54ha, with 51ha of forested habitat. Moderate to steep slopes rise to a maximum elevation of about 100m. On the east side the slopes are moderate with small seepage valleys alternating with drier ridges. The slopes on the west side are steeper and there is a large, steep sided gully towards the north end. The forest is a mix of primarily hemlock (60-80cm average dbh) with spruce (80-120cm average dbh; some to 250cm dbh) and some scattered redcedar (some to 230cm dbh). Alder occurs around the edges. Most of the understory is open moss or bare ground with old, moss covered deadfall. There are patches of salal along the west side, and small areas of spruce seedlings and patches of grass occur around the perimeter. Along the east side there is a small area of blowdown at the south end and a larger area toward the north end. In the interior, on the east side towards the south end, we found limestone caverns along a seepage slope (see predation and mortality).

The 0.7ha north islet has steep rocky sides with the eastern portion higher than the western. The vegetated area is open and mossy under a spruce forest. In the interior of the western section is an area of young (30cm dbh) spruce.

Nesting species:

Storm-Petrel: We found petrel burrows only on the small north islet (Fig. EM400-1). They were distributed sporadically across the islet in association with Ancient Murrelet and Cassin's Auklet burrows. Two burrows were located in the quadrats that were surveyed on the west section (Table EM400-1), giving an average density of 140 burrows/ha, and 20 were

Table EM400-1. Number of Storm-Petrel burrows in 7mx7m plots along transect 7 on the small islet north of Alder Island.

Plot	Storm-Petrel burrows
1	1
2	1
3	0

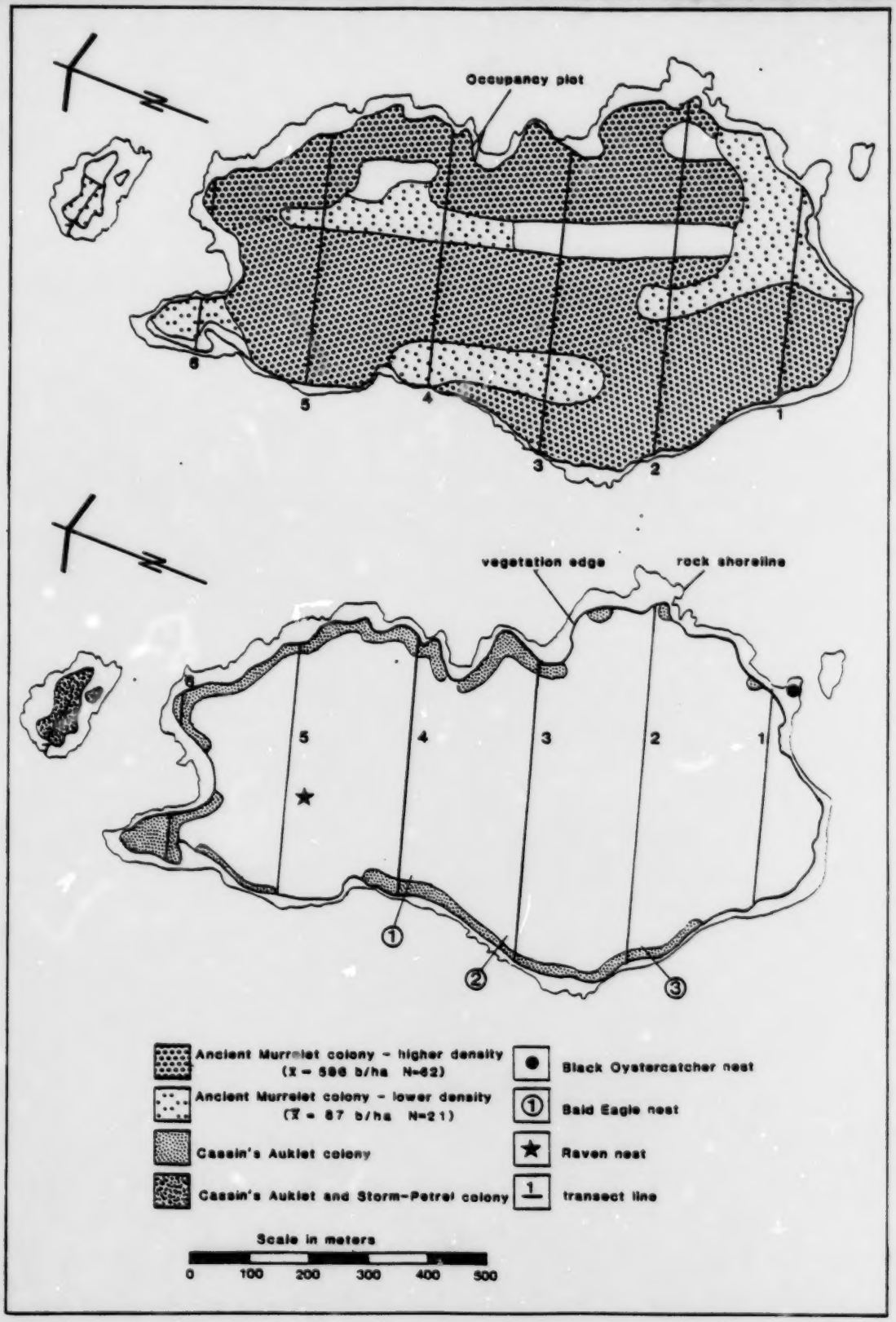

Figure EM400-1. Seabird colony areas and transect locations on Alder Island in 1985.

counted on the eastern section. We estimated the total number of petrel burrows on the islet to be about 70. We were unable to excavate any burrows to determine occupancy or species. We estimated 60 pairs nesting.

Black Oystercatcher: 3 pairs were observed on the east side of Alder Island on 22 April. 3 empty scrapes of rock chips and shells were found on the small connected rock on the southeast corner.

Pigeon Guillemot: Two birds were on the east side on 18 April. They may have been nesting here later in the season.

Ancient Murrelet: Ancient Murrelets were burrowing over most of the drier forested areas of the island as well as on the lower western portion of the northern islet (Fig. EM400-1; Table EM400-2). Burrows were located mainly under live and dead tree roots and old deadfall (Table EM400-3). Mean length of 33 burrows whose ends were reached was 55 ± 4cm. They occurred from shore to the high point of the island on slopes ranging from 0° to 48°.

On 19 and 20 April, the contents of 12 incidental burrows were determined along transects: 1 was empty, 7 contained 1 cold egg, 1 contained 2 cold eggs, and 3 contained adults incubating 2 eggs. We did not use these burrows in our occupancy calculations. In the occupancy plot done on 23 April, of 15 occupied burrows, 4 contained 1 cold egg, and 11 contained adults incubating 2 eggs.

Number of sample plots:	Higher density:	62
	Lower density:	21
	Overall:	83 (4067m^2 - 0.9% of colony)
Average density:	Higher density:	596 ± 55 burrows/ha
	Lower density:	87 ± 36 burrows/ha
	Overall:	467 ± 48 burrows/ha (Table EM400-4)
Colony Area:	Main island:	47.0ha
	North islet:	0.4 ha
	Total:	47.4 ha
Total burrows:	22,136 ± 2275	
1985 Occupancy rate:	65% (15 of 23 known)	
1985 Nesting population:	14,388 ± 1479 pairs	

Staging area: On 22 April at 1815hrs we observed Ancient Murrelets staging between Alder and Arichika Islands and extending 2 km east from there (Fig. EM-2). On a single run through this area 300+ birds were counted.

Table EM400-2. Transect parameters and extent of Ancient Murrelet and Cassin's Auklet colonies on Alder Island in 1985.

Transect parameters								Extent of Colony						
								Ancient Murrelet				Cassin's Auklet		
			Elevation						Distance from nearest shore				Distance from nearest shore		
Transect	Bearing (°)	Total length (m)	Beg. (m)	End (m)	Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevation (m)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevations (m)
1	252	360	1	2	29	13	0-39	0-360	0	110	1-29	-	-	-	-
2	252	629	1	6	77	18	0-50	0-45 105-225 285-629	0	270	1-77	-	-	-	-
3	252	557	12	2	100	23	5-65	0-135 195-557	0	270	2-100	0-15	0	15	12-16
4	252	450	12	4	68	18	0-45	0-450	0	200	4-68	0-15 405-450	0	45	4-20
5	252	435	1	2	30	10	2-32	0-435	0	150	1-30	0-15	0	15	1-4
6	72	135	5	2	5	9	3-15	15-135	0	27	2-4	0-135	0	27	2-5

Table EM400-3. Habitat locations of Ancient Murrelet and Cassin's Auklet burrow entrances on Alder Island in 1985.

Habitat location	Ancient Murrelet		Cassin's Auklet	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	27	14.6	6	15.8
Live tree roots	33	17.8	13	34.2
Stump	41	22.2	7	18.4
Dead tree roots	21	11.4	5	13.2
Log	55	29.7	4	10.5
Rock	3	1.6	2	5.3
Open ground	3	1.6	0	
Into bank	2	1.1	1	2.6
Totals	185		38	

Cassin's Auklet: We found Cassin's Auklet burrows around much of the perimeter of the main island except towards the south end (Fig. 400-1). They were located under roots and in rock crevices within 10-20m of the edge of the vegetation (Table EM400-3). The mean length of 10 burrows was 85 ± 5cm. The density of burrowing was highest at the north end and was low along the west side (Table EM400-5). On the north islet, Cassin's Auklet burrows occurred over most of the vegetated area, though they were most abundant near the edges. All birds found in burrows were incubating.

Number of sample plots: 12 (588m^2 - 1.5% of colony)

Average density: 952 ± 290 burrows/ha

Colony area:
Main island: 3.6 ha
North islet: 0.4 ha
Total: 4.0 ha

Total burrows:
3808 ± 1160
160 burrows (total counted on the higher east section of the north islet)
Total: 3968 ± 1160

1985 Occupancy rate: 80% (12 of 15 known)

1985 Nesting population: 3174 ± 928 pairs

Table EM400-4. Number of Ancient Murrelet burrows in 7mx7m plots along transects on Alder Island in 1985. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Plot	Transect 1	2	3	4	5	6	7
1	1	2	0	2	3	-	0
2	1	4	4	8	2	1	3
3	0	-	0	1	3	0	1
4	2	-	4	0	0	3	
5	0	0	2	4	3	3	
6	0	2	-	0	0		
7	3	9	-	0	5		
8	1	2	0	6	7		
9	0	-	3	6	2		
10	4	-	1	2	1		
11	4	1	2	1	3		
12	3	3	6	2	5		
13		0	3	7	4		
14		0	0	0	5		
15		1	0	0	5		
16		5	0				
17		1	4				
18		1	2				
19		0	4				
20		2					
21		5					

Table EM400-5. Number of Cassin's Auklet burrows in 7mx7m plots along transects on Alder Island in 1985. Plots considered outside the colony are indicated by a dash.

Plot	Transect 1	2	3	4	5	6	7
1	-	-	0	0	11	7	11
2	-	-	-	-	-	0	5
3	-	-	-	-	-	0	2
4	-	-	-	-	-	8	
5	-	-	-	-	-	12	
6-14	-	-		-	-		
15		-		0	-		

Predation and mortality: Most of the remains of predation that we found on the island during our exploration were of Ancient Murrelets (28 feather piles, 3 single wings, 3 pairs of attached wings, 1 decapitated carcass, 30 eggshells, and 1 Bald Eagle pellet with an Ancient Murrelet foot). We also found 1 feather pile and 1 depredated egg of Cassin's Auklet, 2 Herring Gull feather piles, and 3 other gull feather piles. In the quadrats we recorded 8 Ancient Murrelet feather piles and 16 depredated Ancient Murrelet eggshells (Table EM400-6). From this we calculated the density to be 20 ± 8 feather piles/ha, and 41 ± 10 eggshells/ha. The total number of Ancient Murrelet remains was estimated to be 958 ± 366, and the total number of depredated eggs was 1917 ± 465.

We suspect that Bald Eagles were responsible for most of this predation.

As described in the section on habitat, we found limestone caverns on the island. Those underground caverns had funnel-like openings, and Ancient Murrelets were being trapped inside them. In the largest cavern we discovered, we found 13 dead murrelets from this year and numerous old skeletons. There were two live birds caught at the time we were we there, only one of which we were able to rescue.

Table EM400-6. Depredated remains of Ancient Murrelets found in 7mx7m plots along transects on Alder Island in 1985.

Transect	Plot	Feather pile	Depredated egg	Wing	Pair of wings
1	3	1			
1	4	1			
1	10		1		
1	12	1			
2	2	1			
2	19		1		
2	20		1		
2	21		1		
3	2	1			
3	4	2		1	
3	5		1		
3	10		1		
3	12		2		
3	18		1		
4	1		1		
4	5		1		
4	9		1		
4	15	1	1		1
5	2		1		
5	9		1		
5	14		1		
Totals		8	16	1	1

Nocturnal Activity: Table EM400-7 lists records of nocturnal activity of Ancient Murrelets made during our stay on Alder Island.

Table EM400-7. Nocturnal activity of Ancient Murrelets recorded on Alder Island in 1985.

Date	Time	Calls	Arrivals	Comments	Weather
16/04				not too active	wind and rain
17/04	2200			more active than previous night	changeable
18/04	2100			more active than previous night	changeable
19/04	2218-48	1000	40	from outside	clear, no wind
	2225-40	268	16	from in tent	
20/04	2200-15	12	17	more calls later	calm, cloudy
21/04	2227-42	5	1		clear

Associated species:

Double-crested Cormorant - 5 immature

Pelagic Cormorant - 14

Glaucous-winged Gull - 1 pair possibly nesting on SE corner

Bald Eagle - 3 nests on west side: 25m high in 27m spruce with a broken top, 10m from shore; 30m high in 35m spruce, 3m from shore; and 40m high in a 60m spruce, 10m from shore. Adults were seen around all nests.

Northern Saw-whet Owl - 1

Northwestern Crow - We found 9 nests on the south-east corner of the main island: 6 empty, 2 with 2 eggs, and 1 with 5 eggs. Seven nests were located on the ground: 5 under upturned roots, 1 under a fallen log and 1 under a mossy rock; one nest was in the root network of a recently upturned tree, and one other nest was under a fallen log on top of a 0.5m pile of old branches. Nests were built of woven sticks, grass, moss and redcedar bark strips. Nests were within 1 to 20m from shore and between 5 and 50m apart in an open mossy spruce forest. There was a total population of about 40 crows on the main island. On the islet off the north end we found 4 nests: 3 empty and 1 with 5 eggs. Two nests were under stumps, one under a log, and one on a cliff at the base of a tree. Nests were made of sticks lined with moss.

Common Raven - 1 nest 165m from west shore. Adult at nest. 2 pairs seen.

Hair Seal

River Otter - Den and runways at the southeast corner with lots of fresh scat. Most scats contained fish remains, but one recent scat contained a few feathers.

Sitka Deer

EM-410 HUXLEY ISLAND 103 B/6

Location: At the north end of Burnaby Strait. 52°27'N 131°22'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 22 April 1985 (1200-1400hrs).

Colony access: Landings at north and south ends.

Observers: M. Rodway, M. Lemon.

Census method: Exploration. Only the north and south ends on the east side were checked on foot. We explored up to an elevation of 80m.

Description: Huxley is a high, steep-sided, 672ha island with rocky sedimentary shores. We found ammonite and scallop fossils in the rock on the northeast end. The entire west side of the island has been logged in the past and is now a young regenerating forest with numerous old snags. Landslides have occurred along these steep slopes. The northeast and southeast ends where we checked have the most optimal burrowing habitat on Huxley Island with open mossy slopes and knobs under mature hemlock, spruce and redcedar forest. The mid-east slopes are steep with logged areas with young, regenerating forest.

Nesting species:

Pigeon Guillemot: 13 birds were sitting around the rock jumble in the bay at the southeast point on the east side.

No evidence of burrowing by seabirds was found on the slopes explored.

Associated species:

Bald Eagle

River Otter

Sitka Deer

Racoon - Suspected from scats of pure crab shell found under bowls of trees.

EM-420 ARICHIKA ISLAND 103 B/6

Location: South side of Juan Perez Sound, north-east of Huxley Island.

52°28'20"N 131°20'20"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 22 April 1985 (1150-1600hrs).

Colony access: Landing on the beach on the west side at the south end.

Observers: D. Bertram, D. Powell.

Census method: Exploration.

Description: Arichika has rugged rocky shores and steep slopes which rise to a maximum elevation of about 80m. It has a total area of 14.6ha. There is a rocky peninsula with a vegetated knob off the south end and a small beach on the west side where the peninsula connects with the main body of the island. There are cliffs at the south end of the main section and on the north and west sides of the peninsula, and flatter areas near shore at the north end of the island.

The island has 10.0ha of mature spruce and hemlock forest with some alder around the shore. There are areas of older blowdown, especially at the northern end where there are dense 2.5m high stands of regenerating spruce and hemlock. Most of the understory is open and mossy with some salal, huckleberry and grass.

Nesting species:

Pigeon Guillemot: Seven birds were seen off the west side at 1100hrs. We suspect they were nesting later in the season.

No active seabird burrows were found. 1 possible unoccupied petrel burrow was located under a grass tussock on the east side of the southern knob.

Associated species:

Bald Eagle - 1 nest: 30m high in spruce 2m from shore. 2 adults present. 2 immature also sighted.

Peregrine Falcon

Black Oystercatcher - 2 on south peninsula. Possibly nesting later in the season.

Northwestern Crow

Hair Seal

River Otter

Sitka Deer

EM-430 MARCO ROCK 103 B/11

Location: East of Marco Island on the south side of Juan Perez Sound.

52°31'06"N 131°29'31"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 19 June 1986 (2144-2205hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Low, grassy, 0.3ha rock with a profusion of blooming forbs: Epilobium angustifolium, Montia, Achillea millefolium, Plantago major, Fragaria chiloensis, Maianthemum, Fritillaria; also a patch of Rubus spectabilis.

Nesting species:

Black Oystercatcher: We found the following nests:

Emp	2E	Total	Adults
3	2	5	6

Nests were made of rock chips and limpet and mussel shells.

Glaucous-winged Gull: We found the following nests:

2E	3E	Total
1	17	18

Nests were made of grass, Achillea, and Rumex.

Pigeon Guillemot: We recorded the following:

1E	2E	Adults
3	5	30

Adults were flying out of crevices and were on the water.

Associated species:

Northwestern Crow - 1 empty nest made of sticks lined with grass and redcedar bark under a rock.

EM-450 HOSKINS ISLETS 103 B/12

Location: South side of Juan Perez Sound, north of Hutton Point.

52°32'20"N 131°32'50"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 19 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Exploration and total count.

Description: Hoskins are steep-sided islands with a total area of 3.2ha. They are covered with thick salal under a redcedar, hemlock and spruce forest. A few shore pine grow around the perimeters.

Nesting species:

Storm-Petrels: No sign of petrels was found.

Black Oystercatcher: One nest with 2 chicks on north islet. Nest of mussel, limpet and chiton shells. 4 adults were seen.

Pigeon Guillemot: 90 birds counted around the south islet, plus 2 on the north islet. Nine adults were flushed from nests along the edge, some as far as 7m inland up a steep-sided crevice. One nest seen with 1 egg.

Associated species:

Northwestern Crow - 20 (3 fledged young)

River Otter - dens and runways; scats composed of fish

EM-460 TATSUNG ROCK 103 B/11

Location: Off the southwest corner of Ramsay Island.

52°32'43"N 131°20"45"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 20 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Total count.

Nesting species:

Black Oystercatcher: The following nests were found:

Emp	2E	Total	Adults
1	3	4	8

Glaucous-winged Gull: The following nests were found:

Emp	2E	3E	Total
4	5	2	11

Associated species:

Hair Seal - 8 adults with 5 pups

EM-470 RAMSAY ISLAND 103 B/11

Location: North side of Juan Perez Sound. 52°34'N 131°23'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 19 April - 28 May 1984 (main survey), and 20 June 1986 (gull count).

Colony access: Landings on various beaches around the island.

Base camp: Good camping with water on mid-north side.

Observers: 1984: M. Lemon, M. Rodway, D. Bertram, D. Powell, E. Lofroth, M. Biro, T. Robichaud, C. Rodway, J. Rodway. 1986: D. Powell, H. Hay, N. Holmes.

Census method: Exploration and line transects in 1984 and total count for cormorants, oystercatchers and gulls in 1986.

Initial Exploration: To establish the approximate boundaries of the Ancient Murrelet and Cassin's Auklet colonies, 4 workers spent 4 days exploring Ramsay Island in 1984. We walked around the entire coastline. On the periphery of the colonies where there was no more nesting evidence, we explored slopes further into the island up to a maximum elevation of 150m. The lateral extent of the colony was determined from this survey, but only approximate elevation limits were set. In the flatter areas of the island, the east and southeast coast around Yadus Point and the wide valley on the mid-north coast, only the forest edge up to a maximum distance of 100m inland was explored. The steeper slopes in these areas set further back (500-750m) from shore were not explored.

Transects: We surveyed 397 quadrats (7mx7m) spaced 30m apart along 37 transects run at 200m intervals throughout the Ancient Murrelet colony area. In areas of the colony where the coastline was approximately straight (along the south-west shore) the transects were laid out upslope. Where the coastline was irregular with major points (northwest shore at Ramsay Point and the vicinity of Andrew Point) the transects were laid out along parallel bearings to avoid convergence higher up the slope (Table EM470-1). South of Andrew Point the narrow band of Cassin's Auklet colony was surveyed by setting out 27 quadrats (7mx7m) along 17 short, parallel transects at 100m intervals (Fig. EM470-1).

We made a total count of the Cassin's Auklet burrows in the scattered sites along the shoreline east of Crombie Point.

As a "significant" colony, Ramsay Island became an important part of the Permanent Monitoring Program for west coast seabirds. Permanent plots were established for both Ancient Murrelets and Cassin's Auklets (Appendix II).

In the course of our survey, we made morphological measurements of adults, chicks or eggs found in burrows. Adults and chicks were also banded (Appendix III). We also set up two permanently marked experimental plots in an attempt to trap and band Ancient Murrelets at the entrance to their burrows to monitor long term burrow occupancy (Appendix IV).

Description: Ramsay Island has 23.4km of shoreline with a total area of 4557ha. The island has a variable terrain. There are large prominent cliffs on the mid-southwest side and on the southeast side of Crombie Point. Around the cliffs on the mid-southwest side are some of the steepest slopes on the island, some rising to the islands' highest point of over 370m. Steep slopes also occur around Crombie Point and in the interior just west of Andrew Point. A variety of more moderate slopes occur over the rest of the island. In the middle of the northwest side is a broad valley that gradually slopes up to just over 125m in elevation and meets a smaller valley rising from the large bay north of Crombie Point. These valleys create a broad saddle separating the higher west and east sides of the island. The east, and especially the southeast side of the island is almost flat near the shore with steeper slopes in the interior.

The forest on Ramsay Island is a mature mix of spruce, hemlock, and redcedar. Those species occurred in various proportions at all altitudes explored. In most areas the trees are a variety of sizes from small younger trees of 0.2m dbh to old giant redcedars of 3.0m dbh. Mature stands of uniform sized spruce and hemlock were encountered on the southwest side suggesting that these areas may have suffered past blowdowns or fires. Red Alder is frequent along the shore and a few larger alder occur on the slopes toward the interior. Sitka Alder is established on slide slopes, seepage areas, and on the tops of some cliffs.

The understory over much of the island is open and mossy. There are grassy fringes along the shore around and west of Andrew Point and around Crombie Point. Salal becomes patchy and then dominant on the southwest side just north of Crombie Point, and is especially thick along the flatter shoreline along the south and southeast sides. Huckleberry and false azalea are scattered over many open slopes.

Vast swaths of windfallen trees on the northeast side of Ramsay Point, and on the slopes west of Andrew Point were very fresh and probably occurred in the early part of 1984. In the area around Ramsay Point the blowdown extends up the slope to an elevation of at least 130m and the blowdown near Andrew Point up to the ridge crest at 140m.

Nesting species:

Pelagic Cormorant: In 1986, guano was abundant in the caves on the southwest side, but no birds were present. Just east of Crombie Point, on the headland that is almost separated from the main island, there were 28 Pelagic Cormorants in crevices in the rock face. No nests were visible, but nesting was suspected.

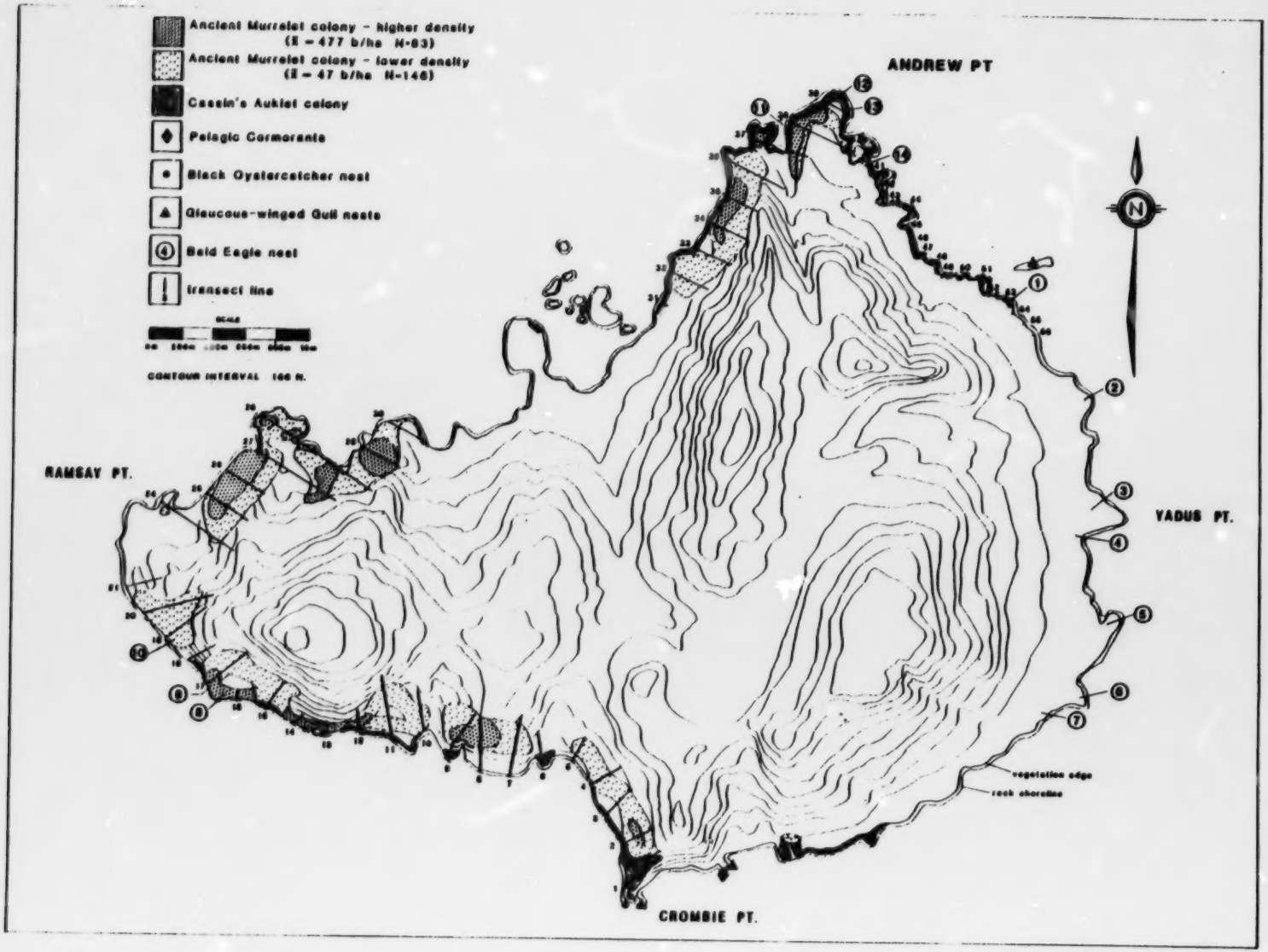

Figure EM470-1. Seabird colony areas and transect locations on Ramsay Island in 1984.

Table EM470-1. Transect parameters on Ramsay Island in 1984.

Transect	Bearing (°)	Total length (m)	Elevations (m) Beg.	End	Max.	Average slope (°)	Range of slopes (°)
1	52	144	8	85	85	22	4-40
2	64	270	5	143	143	36	30-48
3	44	240	2	85	85	20	14-32
4	58	90	4	60	60	35	14-46
5	58	180	6	70	70	20	5-38
6	348	150	10	44	44	12	2-21
7	10	270	50	140	140	17	0-27
8	360	300	52	187	187	28	12-39
9	20-36	270	10	174	174	41	26-58
10	350	540	3	180	180	21	2-42
11	350	420	10	220	220	24	0-47
12	350	210	20	125	125	36	15-53
13	360	97	1	40	40	22	12-32
14	39	111	3	63	63	29	12-40
15	30	300	5	190	190	35	10-45
16	352	93	5	55	55	36	15-45
17	50	330	4	210	210	31	8-46
18	60	420	1	216	216	26	3-41
19	52	330	2	155	155	29	15-39
20	74	390	4	150	150	25	8-40
21	74	240	1	30	30	12	0-27
24	124	570	2	160	160	16	0-37
25	124	300	3	130	130	23	10-40
26	124	270	2	100	115	24	4-50
27	124	540	2	95	95	15	0-28
28	124	960	3	100	100	0,25	0-60
29	124	300	1	82	95	20	9-38
30	124	230	1	8	10	5	0-15
31	116	67	2	25	25	38	23-56
32	116	240	1	50	50	11	2-32
33	116	270	2	62	62	17	5-35
34	116	330	1	115	115	20	5-47
35	116	270	1	156	156	36	20-45
36	116	360	2	24	40	16	0-40
37(a)	116	80	10	2	15	13	6-24
37(b)	116	150	1	15	30	29	8-40
38	116	330	1	10	25	14	8-23
39	296	150	3	10	20	18	11-30
40	234	10	3			3	
41	234	20	*				
42	234	25	*				
43	234	17	*				
44	234	23	*				
45	234	16	*				
46	234	10	*				
47	234	31	*				
48	234	15	*				
49	234	15	*				
50	220	15	*			0	

Table EM470-1. continued.

Transect	Bearing (°)	Total length (m)	Elevations (m) Beg.	End	Max.	Average slope (°)	Range of slopes (°)
51	220	22	5			15	
52	220	15	1			0	
53	220	15	1			0	
54	220	15	1			0	
55	220	15	1			0	
56	220	15	1			0	

* level ground at shore

Black Oystercatcher: In 1984, we found 2 pairs nesting: 1 on the mid-east side on a rock connected by tide to the main island (16 May - empty scrape), and 1 nest on the mid-northwest side of Ramsay Island on rock point in bay southwest of prominent peninsula (13 May - 1 cold egg, 2 adults nearby).

In 1986 there were 2 adults with 2 chicks on Crombie Point, and 2 adults on the headland east of Crombie Point.

Glaucous-winged Gull: In 1984, we observed the following birds on Crombie Point:

28 April - 8 pairs standing on territory and 14 roosting

16 May - 16 pairs standing on territory.

In 1986, the following nests were tallied:

	2E	3E	Total	Adults	Nests (estimated)
Crombie Pt.	1	8	9	18	9
Headland E of Crombie Point				12	6
Rock midway between Yadus Pt. and Andrew Pt.				2	1
TOTAL				32	16

Pigeon Guillemot: In 1984 we suspected Pigeon Guillemots nesting at two locations:

Crombie Point - 17 seen on 16 May

Mid-west side around sea caves - 12 seen on 6 May

In 1986 there was 1 bird on Crombie Point.

Ancient Murrelets: Ancient Murrelets were nesting on the open forested slopes around much of the northwest and southwest sides of Ramsay Island (Fig. EM470-1). From Andrew Point west, then south to Crombie Point murrelets were burrowing on almost all open slopes that are close to shore. The colony extends along 8.0km of shoreline. They were not nesting in the broad gradually sloping valley on the mid-northwest side or in other smaller creek valleys, nor were they nesting on the gentle slopes at Ramsay Point. In the areas of salal north of Crombie Point there was sparse burrowing in the more open and mossy patches.

Burrows occurred from sea level to a maximum elevation of 210m and as far as 395m from shore, on slopes averaging 7° to 42° (Table EM470-2). Burrows were located primarily under trees, roots, and mossy deadfall, as well as under rocks and into open ground (Table EM470-3). The mean length of 37 burrows whose ends were reached was 77 ± 7cm. Blowdowns have occurred in Ancient Murrelet colony areas along transects 25, 35, and 36. There were burrows around the bases of the few standing trees in these blowdown areas. Droppings and eggshells by the burrows indicate that the birds were still using those areas. Colony areas were separated into two density classes.

Number of sample plots:	Higher density:	83
	Lower density:	146
	Overall:	229 (11,221m^2 - 0.8% of colony)
Average density:	Higher density:	477 ± 44 burrows/ha
	Lower density:	47 ± 8 burrows/ha
	Overall:	203 ± 21 burrows/ha
		(Table EM470-4)
Colony area:	Higher density:	39.2 ha
	Lower density:	99.5 ha
	Overall:	138.7 ha
Total burrows:	28,156 ± 2,912.	
1984 Occupancy rate:	64.5 ± 7.3% (20 of 31; Table EM470-5)	

In our previous report (Lemon and Rodway 1984) we quoted an occupancy rate of 66.7 ± 5.9% (34 of 51). To calculate that rate, we included data on 7 burrows located outside of surveyed quadrats and 13 located in permanent plots. We excluded that data from the present calculation because we could not be certain that those burrows were an unbiased sample. Recalculating the occupancy rate changed the estimate of the 1984 nesting population.

1984 Nesting population: 18,161 ± 2783 pairs

Hatching Chronology: The survey on Ramsay Island was completed on 28 May before the major hatching period of Ancient Murrelets, but some chicks had hatched before we left. We found the first chicks in burrows on 27 May.

Table BM470-2. Extent of Ancient Murrelet and Cassin's Auklet colonies on Ramsay Island in 1984.

Transect	Ancient Murrelet					Cassin's Auklet				
	Distance along transect (m)	Distance to nearest shore Min. (m)	Distance to nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Distance along transect (m)	Distance to nearest shore Min. (m)	Distance to nearest shore Max. (m)	Range of elevation (m)	Average slope (°)
1	–					0-144	0	120	8-85	22
2	15-225	15	225	5-125	37	0-15	0	15	5-8	35
3	105-255	105	255	50-85	15	0-15	0	15	2-4	32
4	0-75	0	75	0-50	34	–				
5	75-180	75	180	35-70	15	–				
6	–					0-75	0	45	0-32	13
7	15-225	145	355	55-135	19	–				
8	0-285	110	395	52-183	30	–				
9	45-255	45	255	25-174	39	0-45	0	45	10-25	36
10	15-195	15	195	10-70	17	–				
11	45-135	45	375	32-180	13	0-15	0	15	10-20	33
	225-375				33					
12	15-195	15	195	20-115	36	0-15	0	15	15-20	17
13	15-97	15	97	1-40	22	–				
14	0-111	0	111	3-63	29	–				
15	15-285	15	285	10-170	33	0-45	0	45	5-25	30
16	0-93	0	93	5-55	36	–				
17	15-315	15	315	10-210	34	–				
18	–					–				
19	45-285	45	285	20-140	32	–				
20	15-375	15	375	6-140	23	–				
21	–					–				
24	315-435	165	285	42-90	23	–				
25	45-285	45	285	10-128	26	–				
26	0-255	0	255	0-115	24	–				
27	0-195	0	210	0-95	14	–				
	405-545									
28	15-615	10	285	2-95	15	–				
	735-885				42					
29	0-225	0	225	1-85	21	–				

Table EM470-2. (Cont'd)

Transect	Ancient Murrelet					Cassin's Auklet				
	Distance along transect (m)	Distance to nearest shore Min. (m)	Distance to nearest shore Max. (m)	Range of elevation (m)	Average slope (°)	Distance along transect (m)	Distance to nearest shore Min. (m)	Distance to nearest shore Max. (m)	Range of elevation (m)	Average slope (°)
30	0-75 195-220	0	60	1-10	7	-				
31	-					0-15	0	15	2-6	36
32	15-195	15	195	6-40	10	0-15	0	15	1-6	15
33	105-225	105	225	30-57	15	0-15	0	15	2-5	35
34	15-285	15	285	1-100	21	0-15	0	15	1-2	5
35	0-225	0	225	0-135	35	0-15	0	15	1-8	30
36	45-315	38	200	6-40	20	0-15	0	15	2-4	8
37(a)	15-60	0	30	2-15	17	0-15	0	15	10-12	6
37(b)	15-105	15	105	5-30	29	0-15	0	15	1-5	29
38	15-135 285-315	15	135	6-20	17	0-15 315-330	0	27	1-18	17
39	-					0-45 135-150	0	45	3-18	27
40	-					0-10	0	10	3	3
41	-					0-20	0	20		
42	-					0-22	0	22		
43	-					0-17	0	17		
44	-					0-23	0	23		
45	-					0-16	0	16		
46	-					0-10	0	10		
47	-					0-31	0	31		
48	-					0-15	0	15		
49	-					0-15	0	15		
50	-					0-15	0	15		
51	-					0-22	0	22		
52	-					0-15	0	15		
53	-					0-15	0	15		
54	-					-				
55	-					-				
56	-					-				

Table EM470-3. Habitat locations of Ancient Murrelet and Cassin's Auklet burrows along transects on Ramsay Island in 1984.

Burrow locations	Ancient Murrelet burrows		Cassin Auklet burrows	
	Number	Percent	Number	Percent
Tree base	47	20.1	11	5.5
Live tree roots	45	19.2	57	28.4
Stump	50	21.4	28	13.9
Dead tree roots	15	6.4	39	19.4
Log	45	19.2	23	11.4
Rock	27	11.5	19	9.5
Grass tussock			1	0.5
Into bank	5	2.1	20	9.9
Shrubbery			3	1.5
TOTAL	234		201	

Staging Areas: The major staging area of Ancient Murrelets lay off the west side of the island in Juan Perez Sound, and extended north and east into Ramsay Passage (Fig. EM-2). The staging area appeared to constitute a band which lay a considerable distance offshore, almost to the middle of Juan Perez Sound, and extended from a point west of Crombie Point to Ramsay Rocks and then into Ramsay Passage. The maximum number of Ancient Murrelets counted in this area was 7,500 with 7,000 in Juan Perez Sound and 500 in Ramsay Passage, on 28 April at 2000hrs. On 19 April at 1900hrs, 1,000 birds were counted in Ramsay Passage (Table EM470-6). Ancient Murrelets were observed in Ramsay Passage at all times of the day and night, though numbers were highly variable. They were often heard calling from the water.

We suspect that the birds staging in Ramsay Passage were from both Ramsay Island and House Island (see House Island).

The east side of Ramsay Island was never explored by boat near dusk.

Table B4670-4. Number of Ancient Murrelet burrows in 7m x 7m plots along transects on Ramsay Island in 1984. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Plot	Transect																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21*	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	-	-	-	0	-	-	-	3	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	5	3	-	8	2	-	-	-	-	0	-	-	1	-
2	-	0	-	0	-	-	0	0	-	0	-	-	-	3	1	1	-	-	-	1	-	-	-	1	2	2	1	0	-	-	-	-	0	-	-	1	-
3	-	0	-	1	-	-	0	4	1	0	0	1	3	3	0	1	4	-	0	0	-	-	0	7	1	1	6	0	0	0	0	4	0	1	0	1	-
4	-	1	-	-	0	-	0	1	2	0	0	2	5	3	1	5	0	-	0	0	-	-	1	2	0	0	2	1	-	0	0	1	2	0	3	2	-
5	-	6	0	0	0	-	1	0	4	0	0	1	0	5	0	5	3	-	0	0	-	-	3	2	0	0	4	4	-	0	0	0	0	0	0	0	-
6	-	0	0	1	0	-	0	1	4	0	-	1	0	3	0	7	0	-	0	0	-	-	2	0	1	2	0	1	-	0	0	2	0	0	3	0	-
7	-	0	1	0	0	-	0	3	0	0	-	1	0	5	0	2	0	-	1	0	-	-	0	0	0	1	3	3	-	0	0	1	0	0	0	0	-
8		-	1	0	0	-	0	3	0	0	0	1	0	0	2	1	0	-	0	0	-	-	2	0	0	0	0	0	-	0	0	0	0	0	0	0	-
9		-	-	0	0	-	0	3	1	0	0	0	0	0	1	0	1	-	0	0	-	-	0	1	0	0	0	0	-	0	0	0	0	0	0	0	-
10				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	1	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
11				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	1	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
12				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
13				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
14				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
15				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
16				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
17				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
18				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
19				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
20				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
21				0	0	-	0	3	0	0	0	0	0	0	0	0	0	-	0	0	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-
22-25																																					
26																																					
27																																					
28																																					
29																																					
30																																					
31-33																																					

* transects 22 and 23 fell outside of the Ancient Murrelet and Cassin's Auklet colony.

Table EM470-5. Occupancy of Ancient Murrelet burrows on Ramsay Island in 1984.

Date	Transect	Plot	Empty	Cold egg	Adult + 2 eggs	Predated burrow with eggs	Hatched eggshell	Total occupied	Total known
6/5	9	4			1			1	1
	9	5	1		4			4	5
	9	6	1					0	1
	14	4			1			1	1
15/5	15	4		1				1	1
15/5	16	2			1			1	1
	16	3	1		1			1	2
	16	4			1			1	1
13/5	17	4	1		1			1	2
9/5	25	9			1			1	1
8/5	26	3				1		1	1
	26	6			1			1	1
9/5	28	4	1		1			1	2
	28	8	1					0	1
11/5	28	19	1					0	1
7/5	29	1	1					0	1
	29	2		1				1	1
	29	3	1	1				1	2
	29	5	1					0	1
	29	8			1			1	1
11/5	30	3		1				1	1
4/5	34	4	1					0	1
3/5	38	4		1				1	1
TOTALS			11	5	14	1		20	31
	Permanent Plot **								
20/5	1				1			1	1
20/5	3		1		1			1	2
21/5	4		2					0	2
27/5	6		1		1		1*	2	3
24/5	10				1			1	1
26/5	11				1			1	1
26/5	12		2				1*	1	3

* Chicks hatched and departed burrow.

** Burrows in permanent plots were not examined to determine occupancy but the following contents were incidentally ascertained. These were not included in the sample to calculate an occupancy rate.

Table EM470-6. Observations in Ancient Murrelet staging areas around Ramsay Island in 1984.

Date	Time	Number of ANMU	Location
19/04	1900	1000+	Ramsay Passage
27/04	2000-2100	300+	Ramsay Passage near E end
28/04	2000	7000+	Juan Perez Sound, W side of Ramsay Island, W of Ramsay Rocks
		500+	Ramsay Passage
6/05	2115-2200	200+	Juan Perez Sound, south of Ramsay Rocks (water choppy, difficult to see)

Cassin's Auklet: Cassin's Auklets are burrowing close to shore along 8.3km of the perimeter of Ramsay Island (Fig. EM470-1). West of Andrew Point and along the southwest side of Ramsay Island, Cassin's Auklets are nesting in conjunction with Ancient Murrelets. Nesting areas of these two species overlap along 3.6km of shoreline, such that a total of 12.7km of shoreline of Ramsay Island borders seabird nesting colony. The major continuous Cassin's Auklet colony area extends from Andrew Point, west along 2.5km of shoreline and east along 2.6km of coastline from the point. Above and north of Crombie Point is another significant nesting area. Smaller disjunct populations occur along the southwest side, and on the south side east of Crombie Point. There are a few burrows on the peninsula on the mid-northwest side of the island.

Cassin's Auklets are burrowing on grassy or open mossy slopes and knolls under mature spruce forest. Their burrows are located under trees, roots, deadfall, grass tussocks, and rocks or into the open slope (Table EM470-3). The mean length of 31 burrows whose ends were reached, was 97 $\pm$ 7cm. East of Crombie Point a few burrows were located at shore at the base of the dense understory of salal. Burrows were usually within 30m of the shore although they did extend to a maximum of 120m from shore and to an elevation of 85m on the cliffs above Crombie Point. They occurred on slopes averaging 3° to 36° (Table EM470-2).

Number of sample plots: 46 (2,254m^2 - 1.0% of colony)

Average density: 880 $\pm$ 140 burrows/ha (Table EM470-7)

Colony area:

Andrew Pt.:	11.6 ha
SW coast:	8.2 ha
E. of Crombie Pt.:	2.9 ha
Total:	22.7 ha

Table EM470-7. Number of Cassin's Auklet burrows in 7mx7m plots along transects on Ramsay Island in 1984. Plots considered outside the colony are indicated by a dash.

Transect	Plot											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	0	1	2	5	0	1					
2	11	-										
3	0	-										
6	5	8	0	-								
9	11	0	-									
11	1	-										
12	14	-										
15	6	2	-									
31	0	-										
32	1	-										
33	8	-										
34	0	-										
35	6	-										
36	6	-										
37	6	-	-	2	-							
38	3	-	-	-	-	-	-	-	-	-	-	6
39	12	11	-	-	-	2						
40	10	-										
41	8	-										
42	17	-										
43	0	-										
44	3	-										
45	8	-										
46	2	-										
47	13	0	-									
48	0											
49	0											
50	0											
51	9											
52	0											
53	0											
54	-											
55	-											
56	-											

Total burrows:

Andrew Pt.:	10,208 ± 1,624
SW coast:	7,216 ± 1,148
E. of Crombie Pt.:	625 (total count)
Total:	18,049 ± 2,772

1984 Occupancy rate: 71.4 ± 11.0% (15 of 21; Table EM470-8)

1984 Nesting population: 12,887 ± 2,771 pairs.

Hatching Chronology: We found the first Cassin's Auklet chick on 5 May and were still finding adults incubating eggs at the end of May.

Predation: In the 272 sample plots, which represent 0.83% of the total seabird colony area (159.4ha) on Ramsay Island, a total of 27 feather piles, 12 wings, 24 Ancient Murrelet eggshells, and 5 pellets were recorded (Table EM470-9). This would represent a minimum of 27 depredated birds and 24 eggs, or a density of 20 ± 4 depredated birds/ha and 18 ± 4 eggshells/ha. Extrapolated for the entire colony area indicates that 3,188 ± 638 Ancient Murrelets (most feathers were of Ancient Murrelet, though some feather piles recorded were possibly of Cassin's Auklets) and 2,869 ± 638 Ancient Murrelet eggs had been preyed upon at the time of our survey.

There were fourteen Bald Eagle nests, at least 9 of which appeared occupied, and one active Peregrine Falcon eyrie on Ramsay Island this year (see Associated Species). Eight of the Bald Eagle nests were in either Ancient Murrelet or Cassin's Auklet colony areas (Fig. EM470-1).

Associated species:

Double-crested Cormorant - 1 on 27 April and 6 May

Pelagic Cormorant - 4 in breeding plumage on 28 April

Bald Eagle - A total of 14 nests were located (Fig. EM470-1):

1. mid-east side. Nest 30m high in 40m spruce at shore. On 16 May nest contained 1 egg and one downy, white young (approximately 10cm).

2. mid-east side. Nest 30m high in spruce 5m from shore on point. Two adults present on 21 April.

3. east side. Nest 35m high in 45m spruce 50m from shore. One adult flew from nest and chased 1 immature eagle on 21 April. One subadult around nest as well.

4. east side. Nest 25m high in 35m spruce 5m from shore. On 28 April, 1 adult on nest and 1 adult perched nearby.

5. east side. Nest 30m high in 40m spruce 20m from shore. One adult present on 28 April.

6. southeast corner. Nest 25m high in 30m spruce 5m from shore. One adult on nest on 28 April.

7. southeast corner. Nest 35m high in 40m spruce snag 20m from shore. No adults present on 28 April.

8. southwest side. Nest 40m high in 45m alder 50m from shore on steep bank.

Table EM470-8. Occupancy of Cassin's Auklet Burrows on Ramsay Island in 1984.

Date	Transect	Plot	Empty	Cold egg	Adult +	Adult + egg	Adult + chick	Chick	Hatched eggshell	Total occupied	Total known
5/5	1	3	1							0	1
5/5	1	4				1				1	1
5/5	2	1				2		1		3	3
5/5	6	1	2			1				1	3
6/5	9	1				2	1			3	3
15/5	15	1			1					1	1
15/5	15	2		1						1	1
9/5	33	1	1							0	1
3/5	36	1		1						1	1
3/5	37	4				1				1	1
4/5	39	1	1			2				2	3
4/5	39	6				1				1	1
14/5	45	1	1							0	1
	Totals		6	2	1	10	1	1		15	21
		Permanent Plot *									
28/5		1	1					1		1	2
27/5		2	1					2		2	3
28/5		3						4	1	5	5
28/5		4	1							0	1
28/5		5						4		4	4
25/5		6						1		1	1
27/5		7	2						2	2	4
26/5		8	1						4	4	5
27/5		9	4						3	3	7

* Burrows in permanent plots were not examined to determine occupancy, but some contents were incidentally ascertained. These were not included in the sample to calculate an occupancy rate.

Table EM470-9. Predation evidence found in 7mx7m plots along transects on Ramsay Island in 1984.

Transect	Plot	ANMU eggshells	Feather pile	Wings	BAEA pellet	Dug-up burrow	River Otter scat
1	7		1				
2	6	1					
8	3	1	1				
9	4	1					
9	6	1					
11	3			1			
11	10	1					
12	2		1				
	3		1				
	7	1					
13	3	2	1				
14	2	1					
17	1		1				
24	14	1					
25	8		1				
26	1		1	1			
	2	1					
	3	2				1	
27	1		2	2			
	2	1					
28	1		1				
	2		1				
	4		1				
	8		1				
	13	1					
	15	2					
	20	1					
	26	2					
29	3		1				
	4	1					
	5	1					
34	3		1				
35	1		1	1pr			
	2				1		
36	1		2		1		
	4		1	2	1		1
37	2		1				
	3	1	1				
	4		1	2			
38	3	1					
	4		1				
	6			2			
39	1		1	1			
	4		1				
	6		1		1*		1**
40	1				1		
TOTALS		24	27	12	5	1	2

* with CAAU bill.
** with feathers.

9. southwest side. Nest 20m high in 30m spruce snag 60m from shore. Two adults present on 16 May.

10. southwest side.

11. north end, west side. Nest 24m high in 50m spruce 7m from shore. Adult eagle landed in nest on 3 May. Dead juvenile eagle found at base of tree.

12. north point.

13. north point, east side. Nest 16m high in 30m spruce 20m from shore. Adult landed in nest on 4 May.

14. north end, east side.

Marbled Murrelet - 6 on 16 May

Rhinoceros Auklet - 1 on 28 April

Red-tailed Hawk - 1 seen periodically from 20 April on.

Common Raven - Nest on northwest side, 1.5km southwest of Andrew Point. Nest site is approximately 300m from shore at an elevation of 60m. Seen on 14 May.

Northwestern Crow - present

Hair Seal - 1 on northwest side on 19 April; 12 in a bay on the east side on 16 May; 61 in small bay on tidal shelf north side of Yadus Point on 21 April.

River Otter - Evidence was observed at the following locations:

- south side of Yadus Point, 28 April; den and run.

- north of Yadus Point, 21 April; den.

- south of major creek just south of Andrew Point; dens along east side of the island.

- shoreline around Ramsay Point - runs and scats present

- southeast of Ramsay Point, near Transect 14 - active otter run near point under rocks and tree bases; large piles of scats containing fish scales and bones

- northwest of Crombie Point; otter runways along shore; Otter sighted on the small beach north of Crombie Point.

Deer - present over the entire island.

Goats - 3 (2 billies) east side of Crombie Point, 28 April.

EM-480 RAMSAY ROCKS 103 B/11

Location: West of Ramsay Island. 52°34'03"N 131°27'47"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of Survey: 19 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Total count.

Nesting species:

Black Oystercatcher: 5 adults present.

Glaucous-winged Gull: 5 nests with 3 eggs each - all on northwest side. About 15 adults were present.

EM-490 BISCHOF ISLANDS 103 B/12

Location: Off the southwest corner of Lyell Island. 52°34'30"N 131°33'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 16 June 1985 (1230-1830hrs).

Colony access: Landings in protected coves in middle of northern group and southeast group. Tidal landing on north side of southwest island.

Base camp: Suitable for camping, but little water.

Observers: M. Lemon, M. Rodway, D. Garnier, D. Power.

Census method: Exploration and partial count.

Description: This circle of six islands and associated rocks with a rough, rocky exterior, surrounds a series of quiet bays and channels. Their total area is 66.1ha. The islands' topography consists of undulating rocky ridges with some flat areas behind the inner bays. They are covered with a hemlock, spruce and redcedar forest with some Sitka Alder around the edges. The understory is salal with open mossy or bare areas around the edges and in the interior. There was a recent windfall on the north side of the middle east island, and some larger redcedars had blown over on the north peninsula of the north island. There are small rocky islets off the east side.

Nesting species:

Storm-Petrels: Only two active petrel burrows were found on the Bischof Islands. They were located in a rocky area covered with moss and some salal on the south side of the small southwestern island. The smell of petrels in that area was the only evidence of current nesting. A few likely holes were seen on the two eastern islands but they did not appear to be in use. We may have missed some burrows in the salal but concluded that the petrel population on these islands could not number more than 50 pairs. There was no evidence to identify the species. The BCPM did not report any petrels nesting here in 1977, but in 1971 K. Summers and D. Ellis estimated a colony of 5000 Fork-tailed Storm-Petrels nesting on these islands.

Pigeon Guillemot: 24 were counted at 1230 hrs around the east rocks where we suspected they were nesting.

Ancient Murrelet: No signs of nesting were found. In 1977 the BCPM estimated 300 pairs nesting, and in 1971 K. Summers and D. Ellis estimated 500 pairs. This suggests a gradual decline over the past 15 years.

Associated species:

Bald Eagle - 5 nests:

1. On the outer southwest peninsula of the southwest island, 12m high in 20m spruce 8m from shore. 2 chicks and 2 adults present.

2. On the most southern island, 20m high in 35m spruce 20m from shore.

3. On the most southern island, 22m high in 35m spruce 20m from shore.

4. On the north side of the large northern island, 30m high in 35m spruce 5m from shore.

5. On the north side of the large northern island, on top of 40m spruce with a broken top 20m from shore.

Common Raven

River Otter

Sitka Deer

Racoon - Only suspected from 1 pink and white scat composed of only crab shell found on the middle east island.

Location: North of the east end of Ramsay Island. 52°34'35"N 131°26'20"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 16 April to 28 May, and 10 June 1984 (main island). The island was searched for burrows on 16 and 21 April. 20 June 1986 (small islets off the northeast corner).

Colony access: Landing on beaches on east, south and west sides. Landing is best at higher tides, especially on the south side where a reef is exposed at low tide. The outer islets off the north-east end require drop-offs. The inner islets are accessible from the main island at low tide.

Base camp: Superb. Minimal water on the island. Good drinking water on the opposite shore of Ramsay Island. If an extended stay is planned, permission should be requested from the Skidegate Band Council.

Observers: 1984: M. Rodway, J. Rodway, C. Rodway, M. Lemon, D. Bertram, D. Powell, E. Lofroth, M. Biro. 1986: D. Powell, H. Hay, N. Holmes.

Census methods: Exploration.

Description: Hotspring Island is a relatively flat, 21ha island with some rounder, rocky knolls. Around the hotsprings on the southwest corner of the island are open areas of dense salal with some mossy patches surrounded by wild crabapple. Along the north side of the island is a fringe of alder. The major portion of the island, to the east side, is covered with a mature spruce-hemlock forest with open mossy ground below. Early in 1984, a large blowdown occurred in the mid-north side, devastating a large swath of mature forest. There is a considerable area of young hemlock on the mid-south side. The group of islets off the north-east corner consist of rocky knobs connected by tidal or vegetated lowlands. The knobs are mostly covered with short salal under spruce, with some open, mossy spaces.

Nesting species:

Storm-Petrel: Petrel burrows occurred on the 3 outer northeast islets. They were mostly in open areas or around the edges of the salal. One burrow contained a Fork-tailed Storm-Petrel on egg, and 1 pair of Fork-tailed Storm-Petrel wings were found on the western islet of this group; a pair of Leach's Storm-Petrel wings were found on the most northern islet. The following estimates of numbers of burrows were made:

W islet	- 200
N islet	- 400
S islet	- 400
Total	1000

Both species were suspected nesting due to the depredated wings found, but no proportion was determined. Some burrows were Cassin's Auklet size, but they all seemed to contain petrels (see Cassin's Auklet below). Fork-tailed Storm-Petrels could frequently be heard calling at night. We estimated 900 pairs of both species nesting.

Black Oystercatcher: On 10 June 1984 we found 1 nest with 2 eggs on the tidally connected rock off the south side. The nest was made of rock chips and shells. On 2 June 1986, there was a nest with 1 egg and 1 broken shell at this site. Two adults were present.

Pigeon Guillemot: A maximum of 34 birds were seen in the pass between House and Hotspring Islands on 1 May 1984. In 1986, on the three, separate, north-east islets, 10 nests were estimated on the southern islet, one contained an adult on egg, and 2 depredated eggs were found. On the north islet, 2 adults on nests were observed. There were 5 adults around the west islet. We estimated a total of 15 pairs nesting.

Ancient Murrelet: 1 burrow was found under a hemlock tree on the north side of the island just east of the recent blowdown. One broken eggshell was found at the mouth of the burrow, and there were fresh droppings around the entrance. No other burrows were located, but Ancient Murrelets were frequently heard calling at night in that part of the forest. A maximum of 8 birds were heard calling. There was probably no more than 6 pairs nesting.

Cassin's Auklet: Some burrows found on the northeast islets were Cassin's Auklet size but evidence around the entrances to the burrows suggested that they contained petrels. One depredated Cassin's Auklet egg was found however, so there may be a few nesting. We suspected no more than 10 pairs.

Associated species:

Double-crested Cormorant

Glaucous-winged Gull

Tufted Puffin

Bald Eagle

Northern Saw-whet Owl

Northwestern Crow

Common Raven

River Otter - den and runs on south islet of north-east islets. Scats were of fish - no feathers.

Location: North of Ramsay Island. 52°35'N 131°25'15"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 16-18 April (Exploration and transects), 17 May (islet at east end), and 19 May 1984 (Occupancy).

Colony access: Landing on the southwest beach.

Base camp: Good camping behind landing beach. No water.

Observers: M. Lemon, C. Rodway, J. Rodway, M. Rodway, D. Bertram, D. Powell, M. Biro, E. Lofroth.

Census method: Line transects: 46 quadrats (7mx7m), 40m apart, were surveyed along 5 parallel transects, spaced 138m apart. Transects were run on a bearing of 286° (Fig. EM510-1). As transects were completed early in the Ancient Murrelet nesting season, occupancy was determined on 19 May in a single area on the west side of the island near the top of the slope.

Description: The higher central portion of this 44ha island is surrounded by steep slopes which drop to flat low-lying areas on the east and west sides and to the shore to the north and south. There are connected islets off the east and southwest sides. The forest is a mix of hemlock, spruce and redcedar (most ranging in size from 50-80cm dbh, with some spruce up to 200cm dbh; and some hemlock and redcedar up to 140cm dbh), with some alder around the edges of the low-lying areas. On the northeast slopes are patches of hemlock seedlings. Moss or bare ground and patches of salal, especially along the shore, cover the forest floor. Large tracts of fresh windfall have occurred on the west end and along the north and east sides. Wet seepage occurs on the slopes and on the low-lying east side.

Nesting species:

Pigeon Guillemot: A maximum of 34 birds were seen in the pass between House Island and Hotspring Island on 1 May. We suspect they would nest in the rocky areas along the west side of House Island and on the small islets off the northeast end of Hotspring Island.

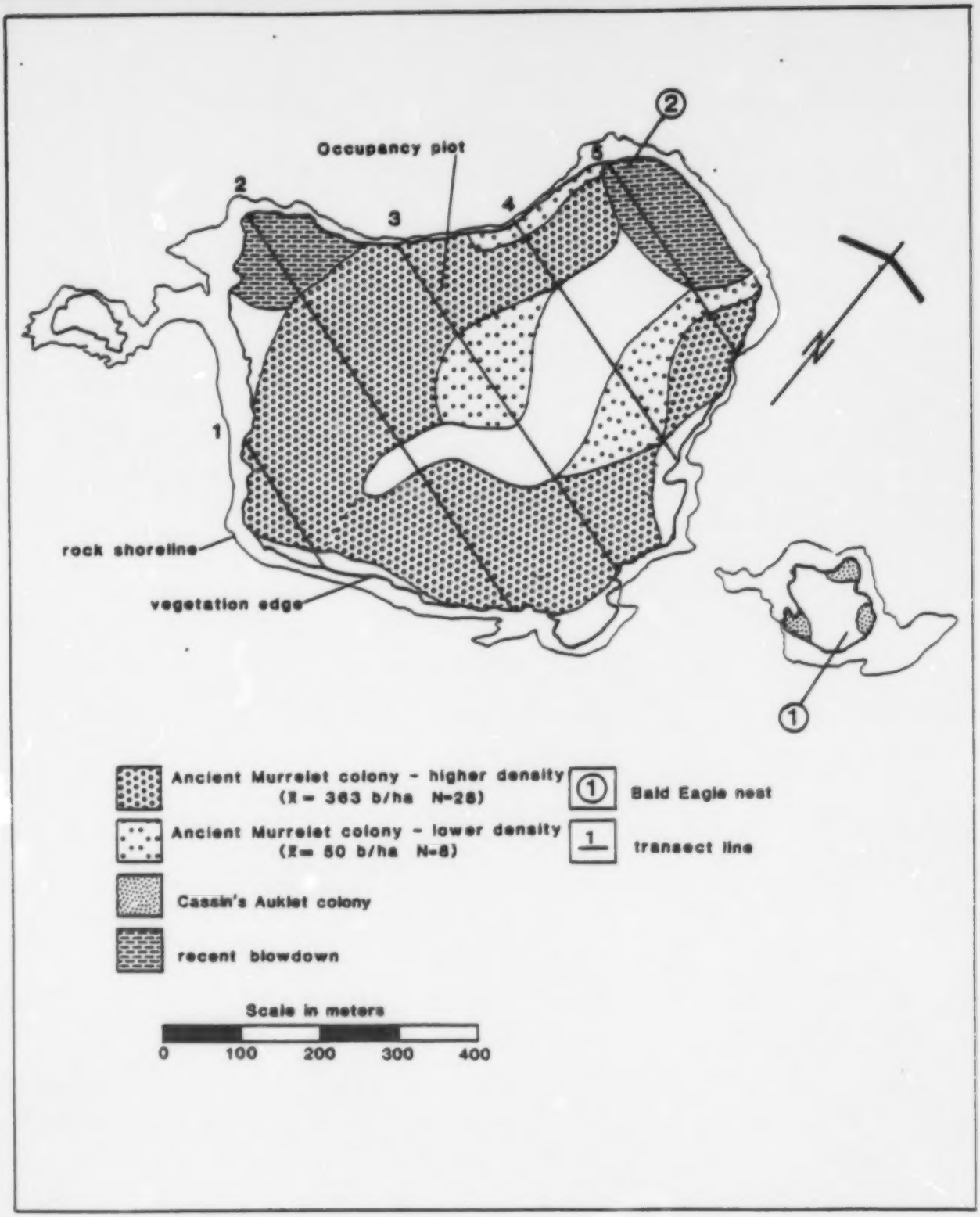

Figure. EM510-1. Seabird colony areas and transect locations on House Island in 1984.

Ancient Murrelet: We found burrows scattered over much of the area from shore to the high point of the main island (Fig. EM510-1: Table EM510-1). One burrow was found on the islet off the east side. They occurred mainly under live and dead tree roots and logs (Table EM510-2). Mean length of a sample of 30 burrows in the occupancy plot was 79 ± 7cm. Burrowing was not encountered along the middle of the higher part of the island towards the north end or in the outer portion of the flat area at the west end. At this west end burrowing began on the flat area about 50m west of the steep slopes. At the north end, the recent blowdown had destroyed burrowing habitat, but a few burrows were still found amongst the windfall and around the bases of remaining trees. The slope of burrowing areas varied from level ground to as steep as 53° and averaged 14°.

Number of sample plots:	Higher density:	28
	Lower density:	8
	Overall:	36 (1764m^2 - 0.9% of colony)
Average density:	Higher density:	363 ± 48 burrows/ha
	Lower density:	50 ± 33 burrows/ha
	Overall:	294 ± 44 burrows/ha (Table EM510-3)
Colony area:	20.0 ha	
Total burrows:	5880 ± 880	
1984 Occupancy rate:	45% (14 of 31 known)	
1984 Nesting population:	2646 ± 396 pairs	

Most burrows that were occupied on 19 May contained adults incubating 2 eggs (10 of 14 - 71%). Three contained 1 cold egg, and 1 held 2 cold eggs.

Staging area: Ancient Murrelets were observed in Ramsay Passage at all times of the day (Fig. EM-2). Their numbers were highly variable with a maximum of 1000 birds sighted on 19 April at 1900hrs. Some of these birds may have been associated with the Ramsay Island colony (see Ramsay Island account). The murrelets were often heard calling from Ramsay Passage. No Ancient Murrelets were observed gathering anywhere else around House Island.

Cassin's Auklet: We found Cassin's Auklet burrows only on the small islet on the east side where there were three patches of burrowing around the perimeter. A total of 55 burrows were estimated. No occupancy was determined. We suspected 40 pair nesting.

Predation: Signs of predation on Ancient Murrelets were found throughout the colony. In 36 plots surveyed within the colony, we found 6 feather piles, 3 single wings, 4 pairs of attached wings, 1 decapitated carcass, and 8 depredated eggs (Table EM510-4). We considered this evidence to represent a minimum of 6 depredated birds. Extrapolating for the entire colony area indicates that a minimum of 673 ± 302 birds had been depredated so far this season. The same calculation for eggs revealed that 881 ± 280 eggs had been depredated in the same time. We suspect the major predators were Bald Eagles.

Table EM510-1. Transect parameters and extent of Ancient Murrelet colony on House Island in 1984.

Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevation (m)
1	286	175	1	1	10	12	2-18	20-175	0	70	1-10
2	286	604	2	1	58	17	0-45	0-220 260-487	0	185	2-58
3	286	580	1	3	65	24	1-53	20-180 260-580	0	220	1-65
4	286	357	1	3	42	21	0-35	20-140 260-357	0	140	1-40
5	286	100	10	35	35	25	10-40	0-100	0	80	10-35

Table EM510-2. Habitat locations of Ancient Murrelet burrow entrances along transects on House Island in 1984.

	Tree base	Live tree roots	Stump	Dead tree roots	Log	Rock	Into Bank	Total
Number of burrows	15	10	10	3	9	3	2	52
Percent of total	29	19	19	6	17	6	4	

Table EM510-3. Number of Ancient Murrelet burrows in 7mx7m plots along transects on House Island in 1984. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

	Transect				
Plot	1	2	3	4	5
1	-	2	-	-	4
2	3	1	1	0	2
3	0	1	5	0	0
4	2	2	1	1	-
5	0	2	4	-	-
6		1	-	-	-
7		-	-	-	-
8		2	1	2	
9		1	0	4	
10		1	0		
11		2	0		
12		0	2		
13		1	1		
14			2		
15			1		

Table EM510-4. Depredated remains of Ancient Murrelets found in 7mx7m plots along transects on House Island in 1984.

Transect	Plot	Feather pile	Depredated egg	Single wing	Pair of wings	Decapitated carcass
1	4	1				
2	1		1	1		
2	3		1			
2	4	1			1	
2	5		1			
2	10		1			
2	11		1			1
3	4	2	1		3	
4	1	1				
4	4	1		2		
4	9		1			
5	2		1			
Totals		6	8	3	4	1

Associated species:

Marbled Murrelet

Bald Eagle - 2 nests were found:

1. On the small islet off the east side. Top of a 35m spruce tree.

2. On the northwest corner of the main island. Only the one on the main island appeared active. 2 adults were present at the nest on 18 April. The nest was 30m high in a 40m spruce at shore.

Red-tailed Hawk

Northwestern Crow - 19

Common Raven

EM-520 KLOO ROCK 103 B/11

Location: North side of Ramsay Island, off Andrew Point.

52°35'18"N 131°22'10"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 11 June 1984.

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway.

Census method: Total count.

Description: Kloo is a jagged rock with near vertical sides.

Nesting species:

Black Oystercatcher: We found 1 nest with 1 egg. Nest was made of rock chips.

Glaucous-winged Gull: There was 1 pair present, but no nest was found.

Associated species:

Bald Eagle - 1 adult: plucking site with feather pile of Sooty Shearwater.

River Otter - scats of fish.

Sitka Deer - pellets.

EM-530 MURCHISON ISLAND 103 B/11

Including the island on the northwest side, and the island and rocks off the east side.

Location: Off the southeast corner of Lyell Island, at the south end of Gogit Passage. 52°36'N 131°27'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 22 April (Most of main island), 1 May (islet connected by tide on east side and the steep west end of the main island), 16 May (islet on the northwest side and the northeast point of the main island) and 10 June 1984 (cliffs on the northeast point). 13 June 1985 (rocks off the east side). 20 June 1986, 1610-1645hrs (rocks off the east side and the cliffs on the northeast corner).

Colony access: Landing at various beaches. Northeast cliffs are surveyed by boat.

Observers: 1984: M. Lemon, M. Rodway, D. Bertram, M. Biro, E. Lofroth, C. Rodway, J. Rodway. 1985: M. Rodway, M. Lemon. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: 1984: Exploration and partial count. In 1985, we only boated past the east rocks. In 1986, we did a total count of nesting gulls on these rocks.

Description: Murchison Island has an area of 425ha. The topography consists of many knolls and ridges creating numerous bays and headlands around the perimeter. There are steep slopes and cliffs on the northeast point and the west end. There is a large lagoon accessible only at higher tides on the north side toward the east end. Much of the island is covered with salal, especially in the interior, but there are many open mossy areas on the knobs and ridges near the shore and on the steeper slopes above the cliffs at the northeast end. The forest is a mix of spruce, hemlock and redcedar, with alder occurring along the shore in wetter areas. Redcedar is dominant in some areas along the northwest side. There has been considerable windfall around the island: on the south end, the mid-southeast side, and on the ridge at the northeast end. The windfall at the northeast end was recent. There was also a large windfall on the northwest side of the islet off the northwest shore of Murchison. The larger islets on the northwest and east sides have similar habitat to the main island. The rocks on the east side are mostly bare with patches of grass and forbs - Achillea and Sedum are common.

Nesting species:

Pelagic Cormorant: In 1984, cormorants were nesting on the cliffs on the east side of the north end of the island. On 10 June, 21 adults were sitting on nests. 36 adults and 5 immatures were present. In 1986, no adult cormorants were present, only 1 immature. There were obvious roost sites on the cliffs but no nests.

Black Oystercatcher: In 1986, we found 1 empty nest and 1 nest with 2 eggs on the east rocks. There were 8 adults present. Nests were made of rock chips and a few mussel chips.

Glaucous-winged Gull: On 10 June 1984, 3 pairs were on territory on the cliffs on the east side of the north end. On 13 June 1985, 12 pairs were sitting on nests or standing on territory on the rocks off the east side. In 1986, we counted the following nests:

		Start	Empty	1E	2E	3E	Total	Adults
E. Rocks:	SW	5	4				9	
	Middle	6	1	3	1		11	
	NE		1			3	4	
TOTAL		11	6	3	1	3	24	
NE cliffs (Not accessible)								7

We estimated 3 nests on cliffs, giving a total of 27 nests for the area. Nests were made of grass, Rumex, Montia, and seaweed (in lower nests only).

Pigeon Guillemot: In 1984, 28 birds were seen in 3 different locations: 6 on the rocks of the east side, 11 at the north end of the larger islet connected by the tide on the east side, and 11 in the bay southwest of this islet. Most of these sightings were early in the season before nesting had begun. In 1986, there were 10 birds around the east rocks.

Ancient Murrelet: We found only 2 active looking Ancient Murrelet burrows on Murchison Island, 1 of which contained a depredated egg. These were located on the west side of the ridge above the cliffs at the north end (Fig. EM530-1). A few old burrows were located on the open slope on the east side of this ridge (3), on the east side just south of the narrow isthmus at the north end (1), and on the west side of the southwest corner (1 with a bit of old egg membrane). We suspect the total population is no more than 20 pairs and is confined to the steep slopes at the north end.

In 1977 the BCPM crew estimated 250+ pairs nesting in this area as well as on the point towards the south end. We noted signs of rats on the island which may be preying on the murrelets.

Cassin's Auklet: We found active burrows on the open slopes on the east and north sides of the north point of the island (Fig. EM530-1). We estimated a total of 50 pairs nesting. This is again less than the BCPM estimate of 150 pairs in 1977.

Predation: The remains of 1 Pigeon Guillemot with all the skin, wings and feet attached was found near an otter den at the south end of the island.

Associated species:

Peregrine Falcon

Common Raven

Hair Seal - 15 on outer east rocks.

River Otter

Sitka Deer

Rat - Droppings and chewings seen.

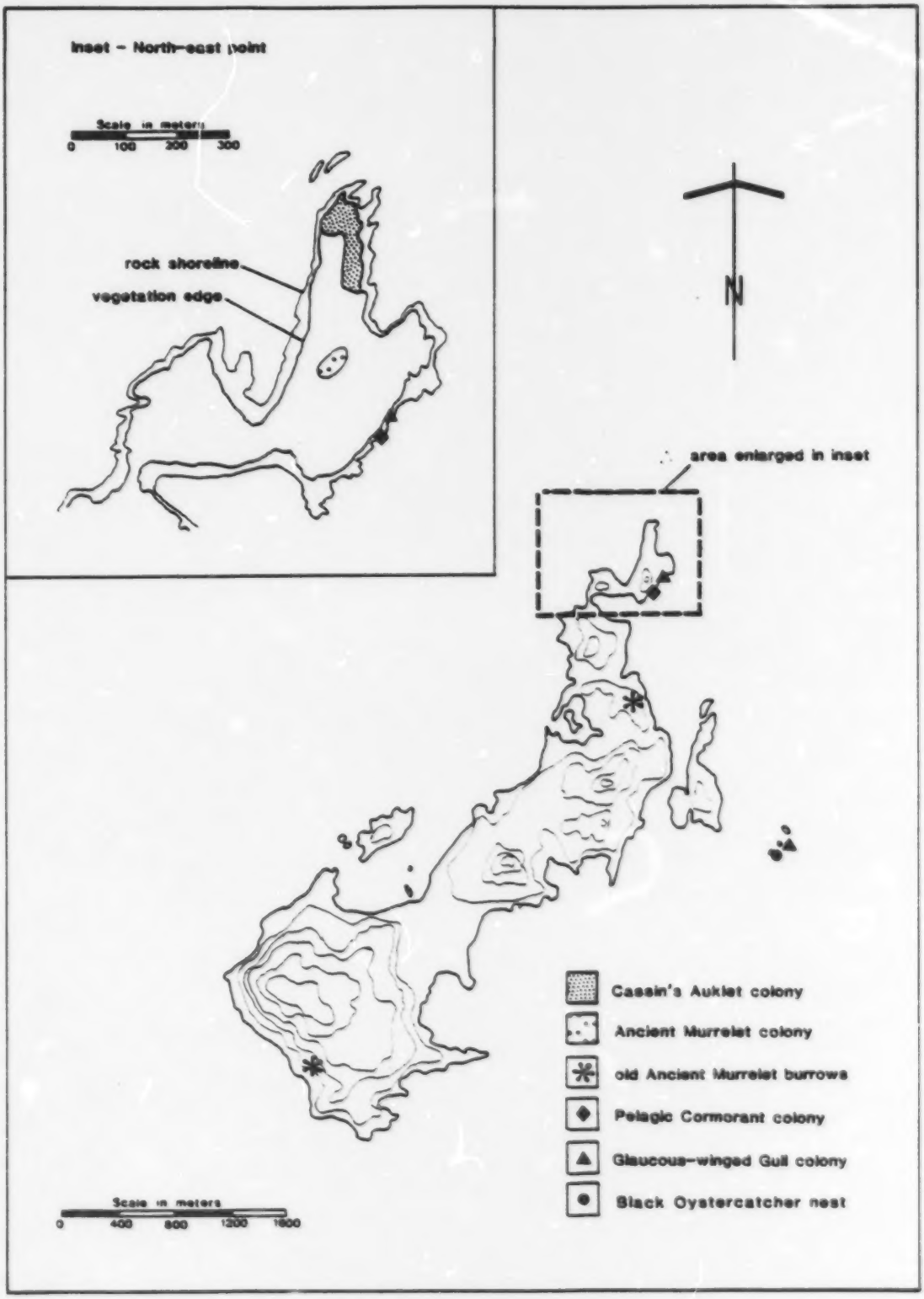

Figure EM530-1. Seabird nesting sites on Murchison Island in 1984.

Location: Off the southeast side of Lyell Island, northeast of Murchison Island. 52°37'40"N 131°25'20"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 29 April 1984, 1200-1500hrs (exploration). 15 June 1985, 1200-1600hrs (transects). 20 June 1985, 1650-1720hrs (survey for gulls on the 44 foot rock at the south end, and the 19 foot rock off the east side).

Colony access: Drop-off from boat.

Base camp: Not suitable for camping.

Observers: 1984: M. Lemon, M. Rodway, C. Rodway, J. Rodway. 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count for gulls, partial count for Cassin's Auklets, and 20 quadrats (5mx5m) spaced 20m apart along 2 line transects run across the island at a bearing of 268° for storm-petrels and Ancient Murrelets.

Description: Agglomerate is a narrow, 20.5ha islet, with steep rocky shores. The ridge that runs north-south down the backbone of the island is higher to the north, where it rises to a maximum elevation of 55m (determined on exploration). The lower southern portion of the island is covered with dense salal under a predominantly spruce forest. Some windfall has occurred in this area. Salal rims the west side and covers the north end of the higher northern section, but gives way to open moss and bare litter in the interior. Grass also grows on some peripheral areas, especially on the east side of this section. Spruce is dominant on the perimeter with cedar becoming more abundant in the interior. In 1984, we encountered two patches of timber in the middle of the northern portion of the island that had been felled, apparently for cruising or testing of some sort, as they had been bucked into sectional rings at various diameters.

The southern 13m (44') rock is mostly bare with a few grassy patches. The east 6m (19') rock is bare. It was only a roosting rock in 1986.

Nesting species:

Fork-tailed Storm-Petrel: Storm-petrels were burrowing over most of the northern section to the highest point of the island, and along the east side of the southern section in association with Ancient Murrelets (Figure EM540-1; Table EM540-1). Burrows were located under roots, logs and in open ground (Table EM540-2). Of the two occupied burrows found, one contained a pair of Fork-tailed Storm-Petrels, and the other a single adult (we were unable to verify if it was incubating). Fork-tailed Storm-Petrels were frequently heard calling from burrows.

Number of sample plots: 20 ($500m^2$ - 0.5% of colony)

Average Density: 640 ± 140 burrows/ha (Table EM540-3)

Colony Area: 9.5 ha.

Total Burrows: 6080 ± 1330.

1985 Occupancy Rate: The contents of 7 burrows were determined, 2 of which contained Fork-tailed Storm-Petrels. The rest were empty. The time of this survey was early in the season for Leach's Storm-Petrels, and some of these empty burrows may likely have been occupied by them later on. The sample was too small to calculate an occupancy rate.

1985 Nesting population: Using the median British Columbia occupancy rate of 91% gives an estimate of 5533 ± 1210 pairs of storm-petrels.

Leach's Storm-Petrel: See Fork-tailed Storm-Petrel above.

Black Oystercatcher: In 1986, we found 2 nests on the south rock: 1 with 2 eggs made of rock chips on a dirt bowl in a small patch of grass; 1 with 1 hatched eggshell and 1 depredated eggshell nearby - made of rock chips on rock (no young found). 4 adults.

Glaucous-winged Gull: In 1986, there was 1 nest with 3 eggs, and 1 empty nest on the south rock. Nests were made of grass.

Pigeon Guillemot: We counted 14 Pigeon Guillemots along the west side in 1984, 12 around the island in 1985, and 6, including 2 flying out of crevices on the south rock in 1986.

Ancient Murrelet: Ancient Murrelets were nesting in the same areas as Storm-Petrels over most of the northern section except on the north point, and sparsely along the east side of the southern section of the island (Fig. EM540-1). Burrows were located under tree roots, stumps, and logs in areas of open ground (Table EM540-2) on slopes ranging from 3° to 60° (average = 26°). They occurred under the fringes of the salal, but did not penetrate into dense thickets.

Number of sample plots: 20 ($500m^2$ - 0.5% of colony)

Average Density: 360 ± 76 burrows/ha (Table EM540-4)

Colony Area: 9.5 ha.

Total Burrows: 3420 ± 722.

1985 Occupancy Rate: No occupancy rate was determined.

1985 Nesting population: Using the median British Columbia occupancy rate of 63% we estimated 2155 ± 455 pairs.

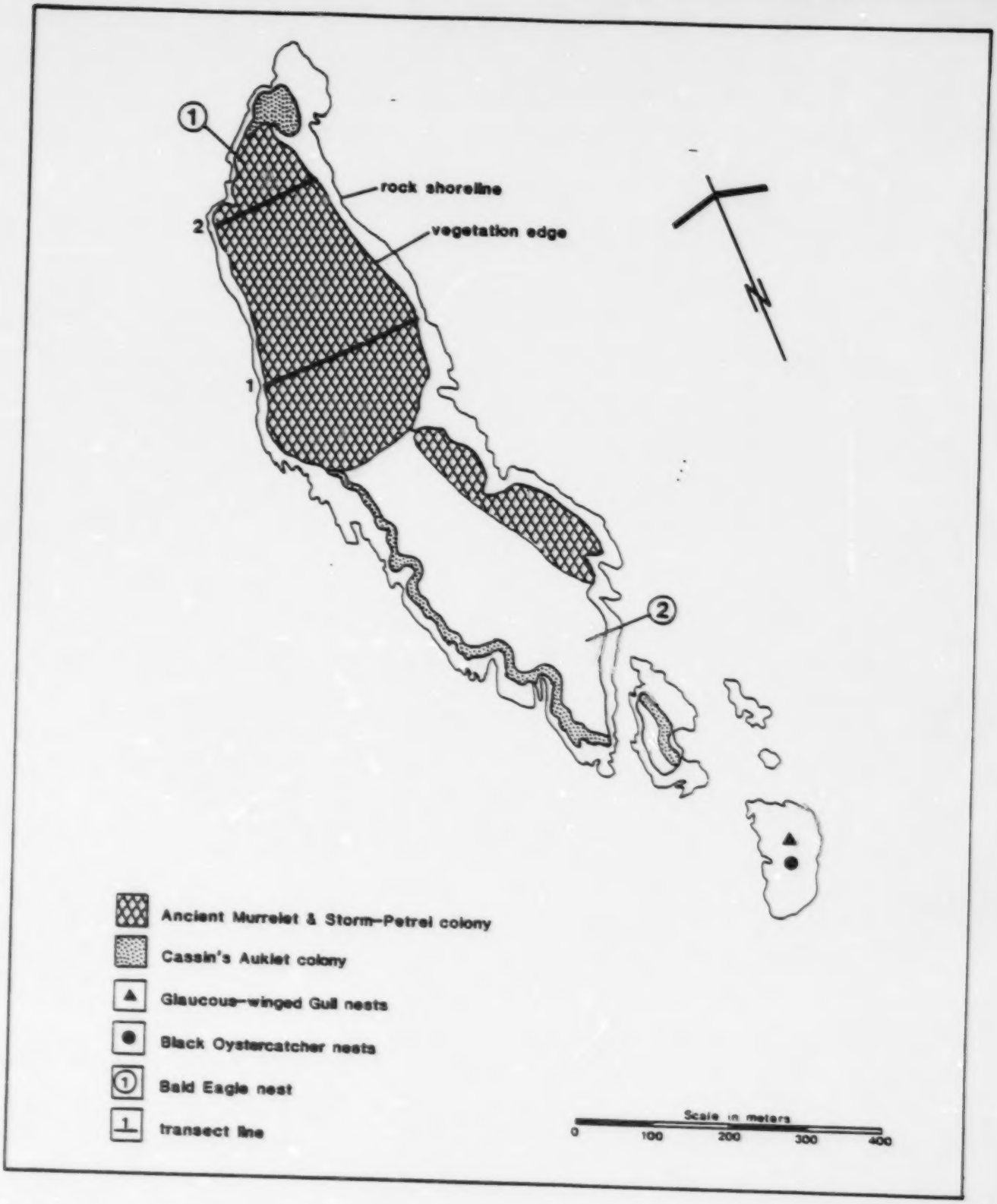

Figure EM540-1. Seabird colony areas and transect locations on Agglomerate Island in 1985.

Table EM540-1. Transect parameters and extent of Ancient Murrelet and Storm-Petrel colonies on Agglomerate Island in 1985.

Transect parameters								Extent of colony							
								Ancient Murrelet				Storm-Petrel			
			Elevation						Distance from nearest shore				Distance from nearest shore		
Transect	Bearing (°)	Total length (m)	Beg. (m)	End (m)	Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevations (m)	Dist. along transect (m)	Min. (m)	Max. (m)	Range of elevations (m)
1	268	230	10	5	38	22	3-45	0-230	0	115	5-38	0-230	0	115	5-38
2	267	154	8	5	37	31	2-60	0-154	0	60	5-37	0-154	0	60	5-37

Table EM540-2. Habitat locations of Ancient Murrelet and Storm-Petrel burrow entrances along transects on Agglomerate Island in 1985.

	Ancient Murrelet		Storm-Petrel	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	1	6	1	3
Live tree roots	5	28	5	16
Stump	3	17	1	3
Dead tree roots	2	11	6	19
Log	4	22	11	34
Rock	1	6	4	13
Open ground	2	11		
Into bank			4	13
TOTALS	18		32	

Table EM540-3. Number of Storm-Petrel burrows in 5mx5m plots along transects on Agglomerate Island in 1985.

	Plot											
Transect	1	2	3	4	5	6	7	8	9	10	11	12
1	2	0	3	0	2	0	0	3	0	0	1	1
2	3	0	3	4	2	0	4	4				

Table EM540-4. Number of Ancient Murrelet burrows in 5mx5m plots along transects on Agglomerate Island in 1985.

	Plot											
Transect	1	2	3	4	5	6	7	8	9	10	11	12
1	1	0	0	0	0	0	2	2	0	1	1	0
2	1	1	1	2	2	0	2	2				

Cassin's Auklet: Cassin' Auklets were nesting under the edges of salal around the south end knoll, the west side on the south half, and on the north end (Fig. EM540-1). In 1984 we counted 64 burrows around just over 100m of shoreline on the south end. We used this "density" to estimate the number of burrows around the rest of the perimeter where they occurred. Burrow frequency was similar on the north end, but they were more sporadic along the west side so we used half the rate for that area, arriving at a total estimate of 275 burrows for the whole island. No occupancy was determined. We estimated 200 pairs nesting.

Predation: We found remains of Fork-tailed Storm-Petrels and Ancient Murrelets. Two petrel burrows had been dug up, with Fork-tailed Storm-Petrel feathers scattered about. From the remains that occurred in our surveyed plots (Table EM540-5) we calculated densities of depredated birds of 80 $\pm$ 37 Fork-tailed Storm-Petrels and 40 $\pm$ 28 Ancient Murrelets per hectare. These densities translate into estimates of the total amount of predation on the colony up to the time of our survey of 757 $\pm$ 347 Fork-tailed Storm-Petrels and 378 $\pm$ 260 Ancient Murrelets.

Table EM540-5. Depredated remains in 5mx5m plots along transects on Agglomerate Island in 1985.

		ANMU		FTSP	
Tran #	Plot #	wing	feather pile	feather pile	pair of wings
1	1	1	1		
1	2			1	
1	4			1	
1	6			1	
2	1		1		
2	2			1	
2	4	1			2
2	7	1			
TOTALS		3	2	4	2

Associated species:

1984: Bald Eagle - 2 nests.

1. at the north end of the island - 20m high in a 30m spruce 10m from shore. No adult present.

2. at south end of the island - 20m high in 40m spruce 20m from shore. An adult was sitting in the nest on 29 April 1984.

Northwestern Crow

River Otter - 1 on the south end.

1986: Hair Seal - 10

EM-550 KAWAS ISLETS 103 B/11

Location: Off the east side of Lyell Island. 52°38'30"N 131°25'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 29 April 1984 (Islets #4&5), 13 June 1985 (Islets #1,2&3), and 20 June 1986, 1725-1750hrs (islet #3).

Colony access: Drop-off from boat.

Base camp: Not suitable for camping.

Observers: 1984: M. Lemon, M. Rodway, C. Rodway, J. Rodway. 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration, partial count (burrowing species), and total count (gulls).

Each islet is described separately and then a summary of breeding and associated species follows. The islets are numbered north to south (Fig. EM550-1). Their total area is 22ha, of which 9.8ha are vegetated.

ISLET 1. (Large north islet)

Description: The main northern section of this islet has steep, rocky sides and is higher than the southern end which lies below a series of rock bluffs running across the islet from east to west. A jumble of large rocks lies along the base of these interior bluffs. Most of the 3.8ha of vegetated area on the islet, especially the higher north area, is covered with thick salal under spruce. There are grass and moss fringes, which in the southern low lying areas extend as far as 15m inland. A few crabapples occur around the edges and there is a 10m wide patch of young regenerating spruce at the north end. On the east side is a small connected knob covered with grass and forbs under a few spruce.

Nesting species:

Fork-tailed Storm-Petrel: We counted 31 petrel burrows and estimated a total of 330. Adults were heard calling from 18 burrows. Most nests were located in the rock jumble that runs across the islet at the base of the steep rocky bluffs. Others were found around the perimeter in grassy areas and under salal and spruce saplings. No evidence of Leach's Storm Petrels was found but our survey was early for their breeding season.

Cassin's Auklet: We counted 60 burrows and estimated a total of 75. Burrows were located under grass, roots and salal around the perimeter and on the small eastern knob. They were well worn with droppings and feathers at their entrances.

ISLET 2.

Description: Rock.

Nesting species:

Black Oystercatcher: 1 pair was present but no nest was found.

Pigeon Guillemot: 2 seen flying out of nest sites.

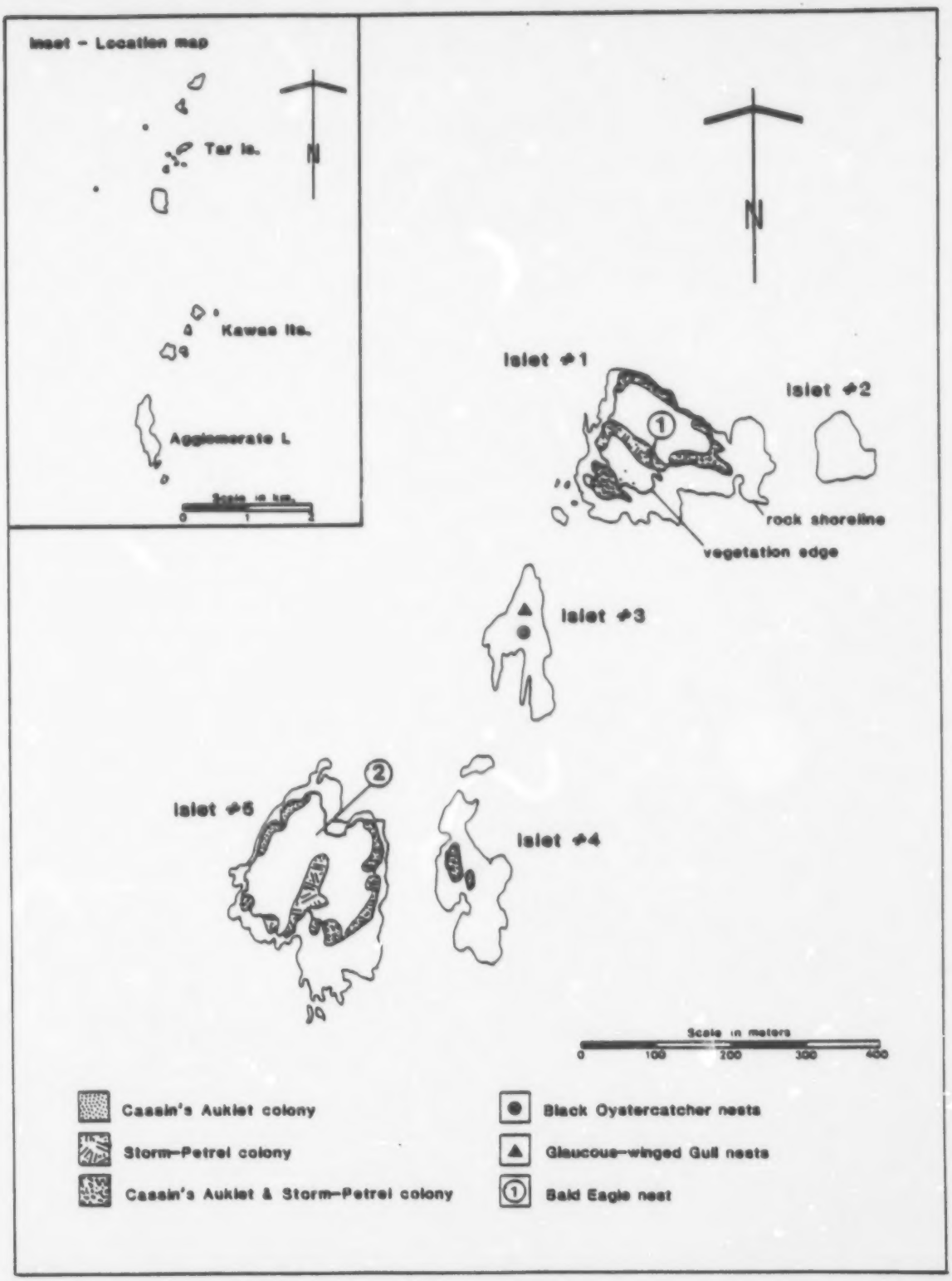

Figure EM550-1. Seabird colony areas on Kawas Islets in 1984 and 1985.

ISLET 3.

Description: This rock is columnar basalt with many vertical projections and cracks. It is mostly bare with grass and Angelica on top.

Nesting species:

Black Oystercatcher: In 1985, we found 1 nest with 2 eggs. The nest was made of stone chips on rock. 2 adults were present. In 1986, we found the following nests:

Emp	1E	3E	Total
1	1	1	3

Nests were made of rock chips and mussel, limpet and abalone shells; 2 were on worn dirt bowls in grass, 1 on rock.

Glaucous-winged Gull: In 1985, we found 9 nests: 6 empty (1 with depredated egg), and 3 with 3 eggs. There were 11 adults present. In 1986, we counted the following nests:

Start	1E	2E	3E	Total
2	1	2	6	11

Nest were made of grass, Rumex and seaweed.

Pigeon Guillemot: In 1985, we observed 2 fly out of crevices. In 1986, 5 adults were present; 1 flew out of a crevice.

ISLET 4.

Description: There is 0.3ha of vegetation on this islet. The islet is grassy (mostly Elymus) with a small grove of spruce trees on the west side. A small grassy pass separates the east and west sides.

Nesting species:

Fork-tailed Storm-Petrel: 20 burrows were counted. Burrows were located mainly in the grassy valley.

Cassin's Auklet: 28 burrows were counted. They were found mainly in the grassy pass.

ISLET 5.

Description: This islet has rocky ridges running north-south with cliffs and sea stacks on the west and south sides. Most of the 5.6ha of vegetated area is covered with salal under spruce. Grassy patches and young spruce thickets occur around the fringes, and small areas of bare ground and moss surrounded by salal occur under some of the larger spruce in the interior. Alder grows along the top of the cliffs on the west side.

Nesting species:

Fork-tailed Storm-Petrel: A total of 435 petrel burrows were counted and estimated. 1 adult was heard in a burrow. Burrows occurred under logs, roots, salal, grass and Maianthemum. They were located around the south and east sides on the ridges and sea stacks as well as in open areas in the chute that runs north-south across the middle of the islet. No evidence of Leach's Storm-Petrels was found but our survey occurred before their breeding season.

Cassin's Auklet: 164 burrows were counted and estimated. We found most burrows along the ridges on the east side, under roots and salal and in grassy or mossy fringes, and a few along the west side on the edge above the cliffs.

SUMMARY OF BREEDING SPECIES ON THE KAWAS ISLANDS

Fork-tailed Storm-Petrel: 785 burrows counted or estimated on islets 1,4&5. Adults were heard calling from 19 burrows. Our surveys occurred too early to determine if Leach's Storm-Petrels were nesting. We estimated 700 pairs of storm-petrels nesting.

Black Oystercatcher: 1 nest on islet 3 and 1 pair on islet 2 in 1985; 3 nests on islet 3 in 1986.

Glaucous-winged Gull: 9 nests on islet 3 in 1985; 11 in 1986.

Pigeon Guillemot: 4 seen flying out of crevices on islets 2 and 3 in 1985; 5 present on islet 3 in 1986.

Cassin's Auklet: 267 burrows counted or estimated on islets 1, 4 and 5. The nesting population was estimated to be 200 pairs.

Predation: We found evidence of predation on Fork-tailed Storm- Petrels (5 wings), Cassin's Auklets (2 inverted skins with wings and legs attached), Sooty Shearwater (1 carcass under the Bald Eagle nest on islet 1) and Red-necked Grebe (1 feather pile). We also found 3 eagle pellets composed of feathers.

Associated species:

Bald Eagle - 1 active nest on islet 1: 25m high in 35m spruce 20m from shore. 1 old nest on islet 5.

Northwestern Crow - 12+

River Otter - Den and runs on islets 1 and 5.

Sitka Deer - Trails and droppings.

EM-560 TAR ISLANDS 103 B/11

Including the rocks to the west in Gogit Passage.

Location: Off the east side of Lyell Island. 52°40'N 131°25'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 9 May 1982 (cliffs on islet 2), 18 May 1982 (islet 11), 13 June 1985, 1030-1730hrs (main survey of all islands except 11) and 20 June 1986, 1755-1846hrs (islets 2, 3 and 11).

Colony access: Drop-offs for most islands. Landing is possible at medium tides on the middle group of islands.

Base camp: Not suitable for camping.

Observers: 1982: M. Lemon, M. Rodway. 1985: M. Lemon, M. Rodway, D. Garnier, D. Power. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration (all islets), total count (oystercatchers and gulls) and partial count (burrowing species and gulls on islet 2).

The Tar Islands and the two unnamed rocks west of them are described here. The total area of all the islands is 20.5ha, of which 8.3ha are vegetated. Each islet is described separately, then a summary of nesting and associated species follows. The islets have been numbered one to eleven from north to south (Fig. EM560-1).

ISLET 1. (Most northern)

Description: This is a low lying islet with an extensive rocky perimeter, especially along the southern side. Above this open rocky shore is an area of grass (Calamagrostis nutkaensis) and forbs which covers about 30% of the vegetated portion of the islet, and merges with an interior of shrubs (salmonberry, twinberry and salal) under spruce. There is a wet seepage area on the mid-east side.

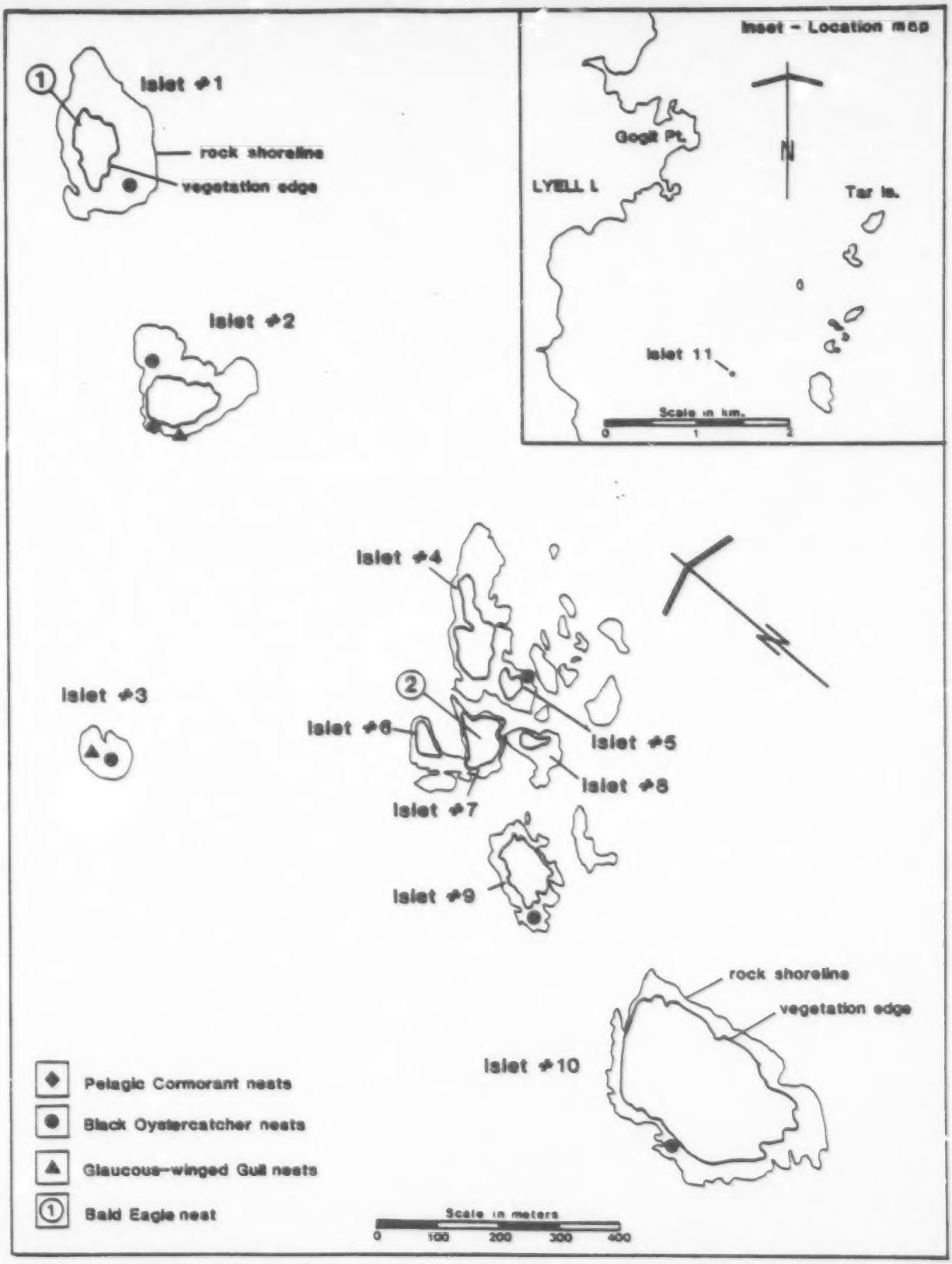

Figure EM560-1. Numbering sequence and nesting sites on Tar Islands in 1985.

Nesting species:

Black Oystercatcher: 1 pair. Nest with 3 eggs on south side on a grassy patch on the rock. The worn earth bowl was lined with rock chips.

Cassin's Auklet: 6 old and 3 active looking burrows were found: 5 old on the southwest knob with Maianthemum growing in their entrances; 2 with feathers and droppings at their entrances in the grass on the north side; and 1 old and 1 active under grass and Maianthemum on the west side. We suspected no more than 10 pairs nesting.

ISLET 2.

Description: The islet is steep sided with rock bluffs on the west side and an extended rock point to the north. Most of the islet is covered with thick salal under spruce, with some small fringes of grass and forbs.

Nesting species:

Pelagic Cormorant: On 9 May 1982 we boated by the west cliffs. There were 22 cormorants in breeding plumage present, and two nests had been partially built.

Black Oystercatcher: In 1985, we found 3 nests with 2 eggs each on the north end. Nests were worn dirt bowls in small tufts of grass on the rock, and were lined with rock chips and shells. In 1986, we found 4 empty scrapes made of rock chips and mussel shells.

Glaucous-winged Gull: In 1985, 7 nests were found on the west side bluffs: 1 with 1 egg, 3 with 2 eggs, and 3 with 3 eggs. Nests were made of grass with some moss and yarrow. 24 adults were standing on territory. Because of the steepness, not all nests were located. We suspected 12 pair nesting. In 1986, we recorded the following:

Start	3E	Total	Adults
1	4	5	18

The nests on the cliffs were not all accessible. We estimated a total of 9 pairs nesting.

Pigeon Guillemot: In 1985, 2 nests with 1 egg each were found in crevices on the west side. 27 adults were flying around the west side.

Cassin's Auklet: 1 burrow with droppings and feathers was located on the south side at the edge of the vegetation. No other burrows were found or suspected.

ISLET 3. (Rock to west of islet 2)

Description: Bare rock with grass tufts.

Nesting species:

Black Oystercatcher: In 1986, we found 1 nest with 2 eggs. The nest was made of rock chips.

Glaucous-winged Gull: In 1985, there were 18 adults on territory. We did not land on the rock. In 1986, we counted the following numbers of nests:

Start	2E	3E	Total
1	3	10	14

ISLET 4. (Islets 4-9 are connected by tidal areas.)

Description: This is an oblong shaped islet with rocky shores. The northeast end is vegetated with grass and forbs under spruce, while the southwest end has an understory of thick 2m high salal, salmonberry, and twinberry.

Nesting species:

Fork-tailed Storm-Petrel: 10 burrows were found along the southeast side. Adults were heard calling from 2 burrows.

Pigeon Guillemot: 13 adults around islet.

ISLET 5.

Description: This is a small islet covered with thick salal under spruce. Furtner east is a separated grassy knob.

Nesting species:

Black Oystercatcher: 3 nests were located on the eastern grassy knob: 2 with 2 eggs and 1 empty.

Pigeon Guillemot: 6 adults on the eastern rock.

ISLET 6.

Description: Islet 6 is covered with dense salal under spruce with some fringes of grass and forbs.

Nesting species:

Fork-tailed Storm-Petrel: 4 burrows found around edge of salal: 3 on the main part of the islet and 1 on one of the two small knobs at the south end.

ISLET 7.

The northwest corner and steep side of this islet were not traversed.

Description: Dense salal with twinberry, rose (Rosa nutkana), and salmonberry under spruce.

Nesting species:

Fork-tailed Storm-Petrel: 8 burrows counted around the edge. We estimated a total of 15 burrows.

Cassin's Auklet: 9 burrows counted around the edge under salal and Maianthemum. A total of 15 estimated.

ISLET 8.

Description: The vegetation is a mix of moss, grass and forbs with salal and twinberry under small spruce (dbh=20cm).

Nesting species:

Fork-tailed Storm-Petrel: 7 burrows counted: 1 with a cold egg under Angelica. Estimated 20 petrel burrows in total.

Cassin's Auklet: 2 burrows counted. Estimated 5 in total.

ISLET 9.

Description: Mostly salal under spruce with some open patches of grass and forbs. There are small cliffs on the south side.

Nesting species:

Fork-tailed Storm-Petrel: 9 burrows counted around south end.

Black Oystercatcher: 1 pair. Nest was not searched for.

Cassin's Auklet: 55 burrows counted, mostly around the south end under grass and Maianthemum and under the edge of the salal.

ISLET 10.

Description: Most of this islet is covered with salal under spruce, hemlock and redcedar with some open fringes of grass, moss and herbs. There are steep rocky areas around the east side.

Nesting species:

Fork-tailed Storm-Petrel: 1 adult was heard in a burrow. 56 petrel burrows were counted under salal around the perimeter and as far as 15m inland. Most burrows were located on the east side above the steeper rock. We estimated a total of 300 petrel burrows.

Leach's Storm-Petrel: 2 adults were heard calling from burrows under salal. (See above account for Fork-tailed Storm-Petrel for total numbers and distribution).

Black Oystercatcher: 1 nest with 1 egg on rock on west side.

Cassin's Auklet: 52 burrows were counted around the perimeter under roots, salal, grass and Maianthemum. Most burrows were along the east side and were worn with droppings and feathers at their entrances. We estimated that there were 75 burrows in total on islet 10.

ISLET 11. (Unnamed rock west of islet 10).

Description: This rock is mostly bare with some grass and forbs - Achillea, Mimulus and Ranunculus.

Nesting species:

Black Oystercatcher: In 1982, we found 1 nest with 2 eggs. In 1986, there was 1 nest with 3 young. Nest was made of rock chips and limpet shells.

Glaucous-winged Gull: There were 6 adults standing on territory when we visited the rock in 1982. Nest building had not yet begun. In 1986, we counted the following nests:

2E	3E	Total
1	8	9

Nests were made of grass, moss, Achillea, Rumex, Cochlearia and feathers.

Pigeon Guillemot: There was 1 bird present in 1986.

SUMMARY OF BREEDING SPECIES ON THE TAR ISLANDS

Fork-tailed Storm-Petrel: 358 petrel burrows were counted or estimated. This included both Fork-tailed and Leach's Storm Petrels. Petrel burrows were found on islets 4,6,7,8,9, and 10. Adults were heard in 3 burrows and 1 cold egg was pulled. Wings and feathers from depredated birds were found on all islets with burrows. We estimated the nesting population of storm-petrels to be 330 pairs.

Leach's Storm-Petrel: See Fork-tailed Storm-Petrel. Definite evidence of nesting by Leach's Storm-Petrels was found only on islet 10 where 2 adults were heard calling from their burrows. Our survey occurred early in their breeding season and some birds may not have arrived.

Pelagic Cormorant: 2 nests being built and 22 breeding birds on islet 2 in 1982. No breeding birds or nests were observed on subsequent visits.

Black Oystercatcher: 8 nests were located on islets 1,2,5,and 10, and 1 was suspected on islet 9 in 1985. Contents were: 1 empty, 1 with 1 egg, 5 with 2 eggs, and 1 with 3 eggs. 1 nest was located on islet 11 in 1982 and 1986, making the suspected total for all the islets 10 pairs.

In 1986, the following totals were recorded for islets 2, 3 and 11.

Islet	Empty	2E	3Y	Total
2	4			4
3		1		1
11			1	1
TOTAL	4	1	1	6

Nests were made of rock chips and mussel and limpet shells.

Glaucous-winged Gull: 21 pairs were suspected nesting on islets 2 and 3 in 1985. The contents of 7 nests were determined: 1 with 1 egg, 3 with 2 eggs, and 3 with 3 eggs. In 1982 3 pairs were seen on islet 11 giving a total estimate of 24 pairs.

In 1986, we found the following nests:

Islet	Start	2E	3E	Total	Adults
2	1		4	5	18*
2	1	3	10	14	
11		1	8	9	
TOTAL	2	4	22	28 (est. total = 32)	

* nests on cliffs on islet 2 were not all accessible.

Nests were made of grass, moss, Achillea, Rumex, Cochlearia and feathers.

Pigeon Guillemot: In 1985, 46 birds were counted around islets 2,4 and 5. Two nests contained single eggs.

Cassin's Auklet: 161 burrows were counted or estimated on islets 1,2,7,8,9 and 10. The nesting population was suspected to be 120 pairs.

Predation: We found signs of predation on Fork-tailed Storm- Petrel (2 pairs of attached wings, 1 single wing, 1 skull in an eagle pellet, and 2 feather piles), Glaucous-winged Gull (1 feather pile), Cassin's Auklet (6 feather piles), Red-necked Grebe (1 skull), Sooty Shearwater (1 skull, 1 wing, and 1 feather pile), Scoter (3 skulls and skeleton), Black-legged Kittiwake (2 feather piles), and Northwestern Crow (1 feather pile).

Associated species:

Bald Eagle - 2 nests:

1. On islet 1, 20m high in 30m spruce 8m from north shore rock.

2. On islet 7, 20m high in 25m spruce 20m from shore.

A pair of adults were calling around each nest and we suspected young in the nests.

Northwestern Crow - 44+ - 1 adult with 2 fledged young.

Hair Seal - 135 including 20 pups.

River Otter - runs on islet 4.

EM-570 TUFT ISLETS

103 B/11

Location: Off the east side of Lyell Island, east of Fuller Point.

52°42'10"N 131°24'36"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 9 May 1982 (1400-1500hrs).

Colony access: Drop-off from boat.

Observers: M. Lemon, M. Rodway.

Description: These islets have a total area of 5.3ha. They have steep rocky sides with grass and forbs on top. The largest islet has a few spruce trees on top.

Census method: Exploration.

Nesting species: No evidence of present nesting by seabirds was found. Five old looking Cassin's Auklet sized burrows were located under grass tussocks and roots on the southwest side of the south islet. Glaucous-winged Gulls and Pigeon Guillemots may nest later in the season.

Associated species:

Pelagic Cormorant - 1 immature

Glaucous-winged Gull - 1 adult

Pigeon Guillemot - 1

Bald Eagle - 2 adult - 1 nest with 2 young.

Northwestern Crow - 4

EM-580 LYELL ISLAND - DODGE POINT 103 B/11,12

Location: The northeast corner of Lyell Island. 52°44'N 131°29'W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of survey: 20 April-28 May and 6-9 June 1982 (main survey). 20 June 1986, 1900hrs (We only boated along the east side).

Colony access: Landing beaches west and south of Dodge Point.

Base camp: Good camping with water at small peninsula west of Dodge Point.

Observers: 1982: M. Lemon, M. Rodway. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Line transects. Twenty-five transects, spaced 200 to 300m apart, were run perpendicular to the shore throughout the colony area (Fig. EM580-1). The starting point of each transect line was marked with a 10cm square piece of copper sheeting nailed on a tree facing the ocean. The transect numbers and identification of the survey were engraved on each marker.

On all but two transects, 30cm wooded stakes wrapped with surveyor's ribbon were placed at intervals along the transect line. Each of these bore the identification of the survey and the ground surface distance from the beginning of the transect. Seventeen transects were run in the same location as those by Blood et al. (1979). Eight others were added in areas where more detailed representation was desired. Transect length varied from 100 to 560m, and were run to altitudes of 62 to 270m.

A total of 459 quadrats, 5mx5m, were laid out every 20m, except along transect 12, which was the first transect run, where they were laid out every 45m until it became apparent that the density of burrowing was low and that more frequent spacing of quadrats was warranted to provide better representation of burrow distribution.

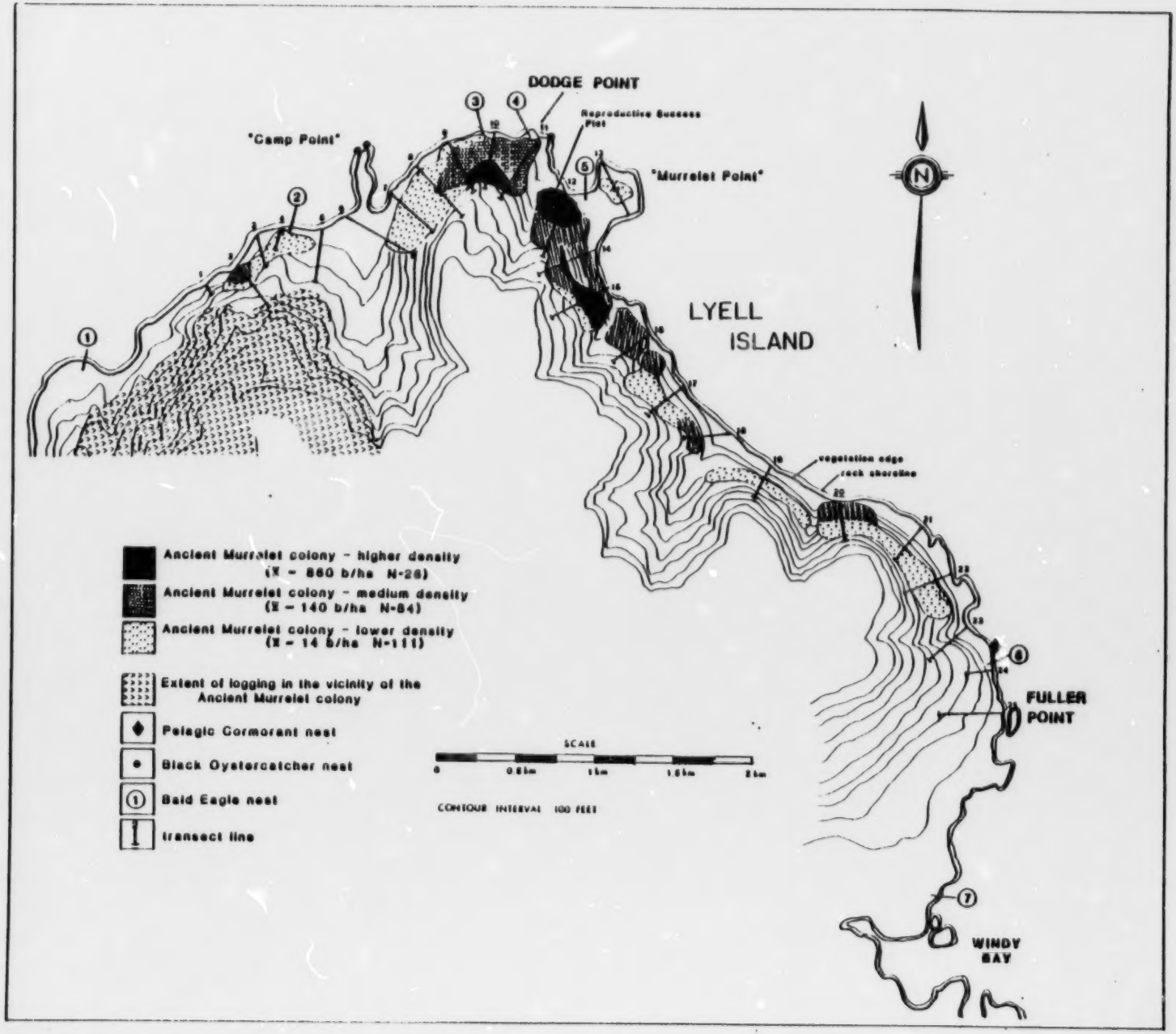

Figure EM580-1. Ancient Murrelet colony area and transect locations on Lyell Island in 1982.

The colony area was mapped on a 1:15840 scale topographic map with 100 foot contours, according to the elevations over which burrowing extended. The occupancy rate was determined from burrows along transects as well as from a large reproductive success plot above the bay on the east side of Dodge Point.

In addition to the colony area, other points along the coast of Lyell were checked for signs of murrelet activity. The forest slopes on the east and west sides of the bay, 3km west of Dodge Point were explored up and into the logging slash. The slopes north and south of Gogit Point and the area south of Fuller Point were searched to 100m elevation. One check into the forest was made at the SE corner of Lyell Island.

Reproductive success and hatching chronology. An area was established in the dense part of the colony above the bay on the east side of Dodge Point to monitor hatching chronology and reproductive success of Ancient Murrelets.

Twenty-five occupied burrows were located on 6, 7 and 8 May. At this time the majority of birds had begun incubation. The burrows were revisited at 10 day intervals thereafter and eggs checked for signs of hatching. If cracks were detected in the eggs, the burrows were then rechecked more frequently to establish hatching dates. The last check was done on 7 June. At this time the outcome of all burrows had been established, with the exception of one late initiated clutch where an adult was still incubating 2 eggs.

Nocturnal activity on the nesting slopes. Four nights were spent in the colony area above Dodge Point. Three of these nights (24 April, 8 and 12 May) were spent at 86m elevation above the bay just east of Dodge Point. This was one of the densest burrowing areas of the Lyell Island colony. The other night (7 May) was spent above the cliffs on the east side of Dodge Point where few burrows were found.

Observations were made from a single position and included all birds that could be heard from that location. Notes were kept of times and frequencies of birds calling, flying in, and flying out. After the first night, observations were made more systematic by making counts every half hour for a five minute period. Counts were also made between these times. The time kept on all night observations was Pacific Standard Time.

Weather was clear on the night of 24 April, and was cloudy, clearing towards morning on the other nights.

Staging area. Seven evening water transects were run from 2150 to 2330hrs on 23 April, 3, 12, 13, 20 and 23 May and 8 June in different areas off the northeast side of Lyell Island, offshore of the colony area.

Predation. Evidence of predation on the Ancient Murrelets was recorded along a 5m strip along the transects. The two Peregrine Falcon eyrie sites were explored for plucking sites, and the area around the two occupied Bald Eagle nests in the Dodge Point area were also checked for evidence of predation on Ancient Murrelets.

Description: The topography around the Dodge Point area is steep with rock bluffs, slides, scree slopes, windfalls, creek valleys, and wet seepage areas frequently disrupting the open forested slopes. The slopes are bare or mossy under the forest canopy. The forest composition in the Dodge Point area is dominated by spruce along the shore, changing, within 40m elevation, to hemlock and redcedar, with large, isolated spruce trees scattered throughout the forest at all elevations explored. Hemlock was the dominant species on most burrowing slopes, though redcedar was regularly present, and at times was the most abundant of the two. No consistant pattern in the relative distribution of the hemlock and redcedar was observed. Redcedar was predominant in areas near the shore as well as high on the slopes.

Nesting species

Pelagic Cormorant: Seen every day in the 1982 survey, particularly around the point 0.5km east of Dodge Point where a maximum of eight birds were perched within a seacave on the north side. These were mainly immature birds with a maximum of three in breeding plumage. They were possibly nesting in this area. In 1986, we observed 1 adult on a nest on the cliffs just north of Fuller Point. One other adult in breeding plumage was present. There were no cormorants present around the cave on the peninsula east of Dodge Point where we had seen them in 1982.

Black Oystercatcher: Three pairs of Black Oystercatcher were found nesting on the NE coast of Lyell. Adults were regularly seen in the vicinity of nests:

1. Nest on the rock point 1km west of Dodge Point (Camp Point), made of rock chips:

    14 May - nest with 3 eggs; adult in nest; adult nearby.
    24 May - three eggs.
    10 June - nest empty; young were not found.

2. Nest of rock chips on Camp Point, 5m from other nest:

    24 May - nest with 3 eggs; adult on nest
    10 June - three eggs; all pipped through, ready to hatch

3. Nest on rock, of rock chips and shells at Dodge Point:

    20 May - 1 empty scrape; 2 adults present and excited.

A pair of Black Oystercatchers were observed in the bay south of Murrelet Point on 6 and 13 May. They may have been nesting in that area, but no nest was found. Groups of oystercatchers were seen in the Windy Bay area (25 April - 7, 10 May - 18 and 6 June - 12). Two oystercatchers were seen feeding on the tidal flats in Powrivco Bay (27 and 28 May).

Pigeon Guillemot: One to four birds in summer plumage were seen daily off Dodge Point. The birds may have nested at Dodge Point later in the season. Twenty-two birds were seen in Gates Creek Bay on 18 May.

Ancient Murrelet: The main concentration of the Ancient Murrelet colony was around Dodge Point (Fig. EM580-1). From there the colony extended down the east coast to within 750m of Fuller Point, and westward along the north coast for 1100m. There was an isolated patch of burrowing further west from 1600 to 2200m west of Dodge Point. At the Fuller Point end of the colony was an area that appeared to have been sparsely burrowed in the past. Along transect 23 two old eggshells were found but no present sign was observed. No evidence of burrowing was found in other areas explored along the coast of Lyell Island, described in the census method section, though habitat appeared suitable.

In the colony area, there was considerable variation where burrowing occurred with respect to altitude and distance from shore. Burrowing started from 10 to 80m from shore and ranged as far as 500m inland. Altitude of burrowing ranged from as low as 5m to as high as 250m (Table EM580-1).

Burrowing generally occurred in moderately sloping open forest with a predominantly bare ground or mossy understory (major moss species were Eurhynchium oreganum and Rhitidiadelphus loreus), often above steep cliffs, scree slopes or wet seepage areas. Burrows were most often associated with tree roots or mossy deadfall in these areas. Some burrows occurred beneath hemlock thickets, windfalls, and beneath rocks on the edge of talus slopes (Table EM580-2).

There was a large open grassy area under Sitka Spruce on the east coast extending to a maximum elevation of 86m (transects 17 to 19), in which no burrows were found.

The density of burrows varied throughout the colony (Table EM580-3). Burrowing areas were categorized into three density classes: low, medium, and high. An area was considered low density if signs of burrowing were infrequent and burrows within plots were rare. Medium areas were defined as having continuous sign of burrows along the transects with one or two burrows occurring within some of the plots. High density areas had one or more burrows in every plot and continuous burrowing between plots. Densities were calculated as the average of all plots falling within each category area (Table EM580-4). All three classes occurred at both high and low elevations and at various distances from shore. High density areas occurred at Dodge Point and the area just south of it. Medium areas usually surrounded the high density areas. In addition, two small areas of medium density occurred at the southern end and one small area at the western end of the colony. Low density areas were found at the colony periphery (Fig. EM580-1). Total number of burrows was calculated using all sample plots to determine the average burrow density in the colony.

Table EM580-1 Transect parameters and extent of Ancient Murrelet colony on Lyell Island in 1982.

	Transect parameters						Extent of colony				
Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Dist. to nearest shore Min. (m)	Dist. to nearest shore Max. (m)	Range of elevation (m)	Comments
1	144	100	4	67	37	17-46					no fresh sign
2	142	260	5	166	33	16-56	20-140	20	140	22-112	
3	165	260	1	91	21	4-46	120-200	93	154	60-88	
4	190	160	3	62	27	5-45	80-160	80	*	24-*	colony continues
5	188	360	1	91	16	0-40					no colony along transect
6	119	560	1	175	20	0-50	320-540	190	288	43-162	
7	130	500	3	221	32	1-63	140-500	140	500	38-221	
8	137	440	1	252	35	13-60	80-400	80	400	35-235	
9	152	480	3	230	32	5-62	60-420	60	420	18-211	
10	188	360	3	210	34	3-58	10-290	10	290	12-190	
11	214	450	1	187	26	0-55	10-440	10	338	5-170	
12	202	450	1	230	30	6-65	22-382	22	382	6-201	
13	153	300	16	50	18	0-59	100-300	83	128	43-50	
14	247	380	1	270	35	3-51	50-350	50	350	16-250	
15	243	420	4	231	32	14-43	60-330	60	330	20-185	
16	232	400	1	167	28	7-46	30-330	30	330	14-139	
17	232	380	4	228	38	21-50	150-290	150	290	93-187	
18	264	440	3	150	21	0-50	250-350	153	204	74-121	
19	207	320	2	217	37	18-55	120-210	120	210	77-141	
20	170	340	4	240	41	31-58	10-290	10	290	11-208	
21	220	300	10	190	39	7-60	180-290	180	290	116-187	
22	248	340	3	215	39	26-60	120-270	120	270	70-176	
23	236-230	400	1	168	25	6-54	250-320**	250	320	109-142	deserted part of colony
24	263	240	12	92	18	4-42					no sign
25	269	300	1	99	16	1-38					no sign

* Transect ended before end of colony to avoid convergence with transect 3.
** Old burrows in this area.

Table EM580-2. Habitat locations of Ancient Murrelet burrows along transects on Lyell Island in 1982.

Location	Number of burrows	% of total
Under tree base	30	31
Under tree roots	24	25
Under fallen logs	17	18
Under stumps	16	17
Under rock	6	6
Into bank	3	3
TOTAL	96	100

Table EM680-3. Number of Ancient Murrelet burrows in 5mx5m plots along transects on Lyell Island in 1982. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Plot	Transect 1	2	3	4	5	6	7	8	9	10	11	*12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	1	–	–	–	–	–	–	–	1	0	**1**	–	–	–	–	–	–	–	1	–	–	–	–	–
3	–	0	–	–	–	–	–	–	–	0	0	**0**	–	–	–	1	–	–	–	0	–	–	–	–	–
4	–	0	–	–	–	–	–	–	0	0	0	**2**	–	1	0	0	–	–	–	1	–	–	–	–	–
5	–	2	–	1	–	–	–	0	0	1	0	**1**	–	1	0	1	–	–	–	2	–	–	–	–	–
6	–	0	–	0	–	–	–	0	0	0	0	**4**	0	0	**2**	0	–	–	–	0	–	–	–	–	–
7		0	0	0	–	–	–	0	4	0	1	0	0	0	**4**	0	–	–	0	0	–	0	–	–	–
8		0	0	0	–	–	0	0	0	0	0	0	0	–	**1**	0	–	–	0	0	–	0	–	–	–
9		–	0	0	–	–	0	0	0	1	0	0	0	–	**1**	0	0	–	1	0	–	0	–	–	–
10		–	0		–	–	0	0	0	0	0	–	0	–	**2**	0	0	–	0	0	0	0	–	–	–
11		–	0		–	–	0	0	0	0	0	–	0	–	**0**	0	0	–	0	0	0	0	–	–	–
12		–	–		–	–	0	0	0	**9**	1		0	**6**	**2**	0	0	–	–	0	0	0	–	–	–
13		–	–		–	–	0	1	0	**2**	1		0	**5**	**1**	1	0	–	–	0	0	0	–	–	–
14		–	–		–	–	0	1	0	**1**	0		0	0	0	0	0	0	–	0	0	0	–		–
15					–	–	0	1	0	**2**	1		0	0	0	0	1	1	–	0	0	–	–		–
16					–	–	0	0	0	–	0		0	0	0	0	–	1	–	–	–	–	–		–
17					–	0	0	0	**1**	–	0			0	0	0	–	0	–	–		–	–		
18					–	0	0	0	**3**	–	**1**			1	–	–	–	1		–		–	–		
19					–	0	0	0	**2**	–	**2**			–	–	–	–	–					–		
20						0	0	1	**1**		0			–	–	–	–	–					–		
21						0	0	0	0		–				–	–		–					–		
22						0	0	–	0		–				–			–							
23						0	0	–	–		–							–							
24						0	0		–																
25						0	0		–																
26						0	0																		
27						0																			
28						0																			
29						–																			

* plots on this transect spaced 45m apart

Table EM580-4. Ancient Murrelet burrow density classes and colony area on Lyell Island in 1982.

	Number of plots	Average density burrows/ha	Colony area (ha)	Total burrows
High density	26	860 ± 160	16.3	14018 ± 2608
Medium density	84	140 ± 30	49.9	6986 ± 1497
Low density	111	14 ± 7	59.6	834 ± 417

Number of sample plots: 221 (0.55ha. - 0.4% of colony)

Average density: 163 ± 28 burrows/ha

Colony area: 125.8 ha

Total burrows: 20,505 ± 3,522

1982 Occupancy rate: 52.0 ± 3.0% (39 of 75; Table EM580-5)

In our previous report (Lemon and Rodway 1983) we quoted an occupancy rate of 52.3 ± 3.2% (45 of 86). To calculate this rate, we included data on 11 burrows located outside of surveyed quadrats. We excluded that data from the present calculation because we could not be certain that those burrows were an unbiased sample. Recalculating the occupancy rate made a slight change in the estimate of the 1982 nesting population.

1982 Nesting population: 10,663 ± 1930 pairs

Reproductive success and hatching chronology. Most hatching occurred from 15 May to 9 June with one clutch hatching about 21 June. Hatching peaked in the third week of May when 52% of the sample clutches hatched (Fig. EM580-2, Table EM580-6).

Of the 25 clutches, 76% contained 2 eggs. Total eggs laid in the sample burrows was 46. Sixty-five percent of these hatched and the young chicks departed from the burrows. For 5 clutches no adults were found in attendance, and it was assumed that incubation was never initiated. Two other clutches were initially incubated but deserted on the third visit. It is not known whether our activities caused the birds to desert or if some other factor was involved (Table EM580-7).

Table EM580-5. Occupancy of Ancient Murrelet burrows along transects on Lyell Island in 1982.

Date	Transect	Plot	Empty	1 cold egg	2 cold egg	3 cold eggs	Adult*	Adult +1 egg	Adult +2 eggs	Hatched eggshell	Total occup.	Total known
21/05	2	5	2								0	2
12/05	9	19	1								0	1
20/05	10	9							1		1	1
20/05	10	12	1								0	1
5/05	11	19	1								0	1
23/04	12	2							1		1	1
23/04	12	6	1								0	1
26/04	14	13	1						2		2	3
9/06	20	2								1	1	1
6/05	Reproductive plot		10	2			5		3			
7/05	Reproductive plot		7	2	1				3			
8/05	Reproductive plot		8	2	1	1	2	2	5			
17/05	Reproductive plot		4				2	1	2		34	63
Totals			36	6	2	1	9	3	17	1	39	75

*contents not completely determined

Comparison of hatched and depredated eggshells: In order to ascertain the shape of hatched Ancient Murrelet eggshells, 13 burrows where chicks had hatched were inspected. In all of these, only the eggshell membrane remained, with only a few pieces of eggshell left adhering to the membrane. Blood vessels and congealed faeces remained on the inside surface of the membrane. Nine of those we checked had been cracked open around the short axis of the egg, while two had been cracked open longitudinally. In the remaining two burrows the eggshell membranes were in shreds or ripped into a spiral. All of these remains were found either within the nest bowl itself or in the burrow tunnel.

The above observations suggest that few remnants of successfully hatched eggs occur in the colony. Only depredated shells remain intact and persist, while hatched eggshells are destroyed in the burrows. Since eggshells found on the open forest floor are likely remnants of predation, they could not be used to indicate a level of reproductive success.

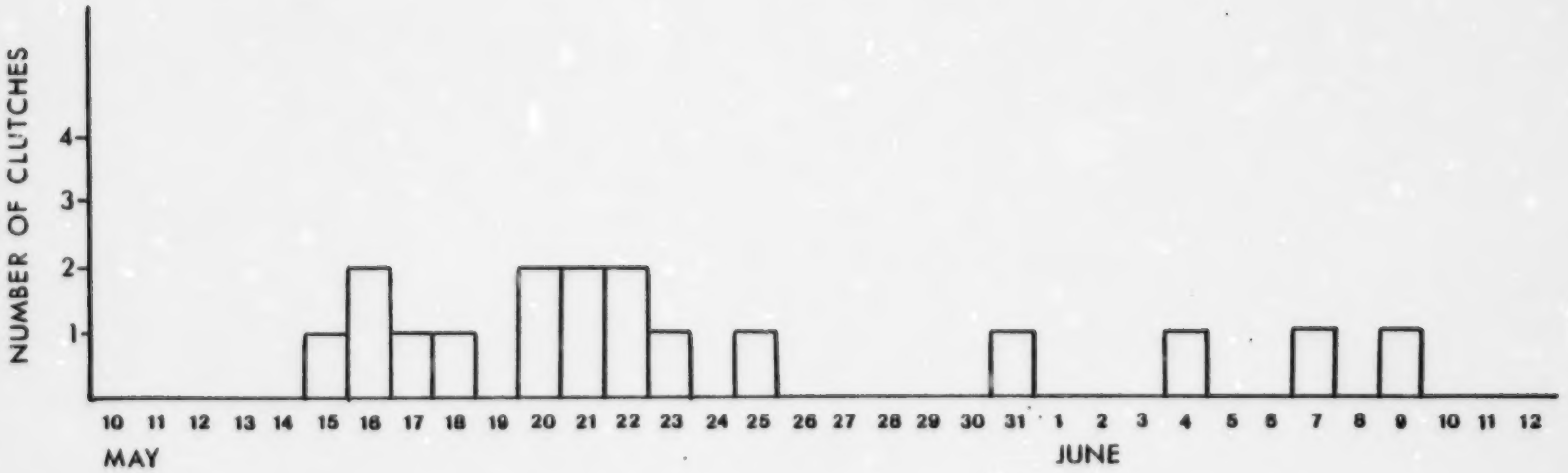

Figure EM580-2. Hatching dates of Ancient Murrelets on Lyell Island in 1982.

Table EM580-6. Summary of results from Ancient Murrelet reproductive success plot on Lyell Island in 1982.

Burrow	Contents of burrows					Approximate hatching date
	6-8 May	17 May	22 May	27 May	07 June	
1	adult+ 2 eggs	adult+ 2 chicks	gone			May 16
2	adult+ 2 eggs	adult+ 2 eggs		adult+ 2 eggs 3-4 day cracks	hatched eggshells	May 30-31
3	1 cold egg	adult+ 2 eggs		adult+ 2 eggs no cracks	adult+ 2 eggs pipped	June 7
4	adult+ 2 eggs	adult+ 2 eggs 3-4 day cracks		hatched eggshells		May 20-21
5	1 cold egg	2 cold eggs		adult+ 2 eggs	adult+ 2 eggs no cracks	
6	2 cold eggs	2 cold eggs		empty, 2 freshly predated eggs below burrow		
7	1 cold egg	2 cold eggs		empty, 2 freshly predated eggs nearby		
8	empty	never used				
9	adult+ 2 eggs	adult+ 2 eggs 3-day cracks	hatched eggshells			May 20
10	1 cold egg	1 cold egg		1 cold egg	1 cold egg	
11	adult+ 2 eggs	adult+ 2 eggs 3 day cracks	adult+ 2 eggs 1 no cracks 1-pipped hole	1 hatched shell 1 egg - no development		May 22-23
12	adult+ 2 eggs	adult+ 2 eggs 2-3 day cracks	adult+ 1 chick + 1 egg	1 hatched eggshell		May 21-22
13	adult+ 1 egg	adult+1 egg slight crack		hatched eggshell		May 22-23
14	1 cold egg	1 cold egg		1 cold egg	1 cold egg	
15	2 cold eggs	adult+ 2 eggs		adult+ 2 eggs	adult+2 eggs cracked	June 9
16	adult+ 2 eggs	adult+ 2 chicks		hatched eggshells		May 16

Table EM580-6. cont'd

Burrow	Contents of burrows					Approximate hatching date
	6-8 May	17 May	22 May	27 May	07 June	
17	adult+ 2 eggs	adult+ 2 eggs no cracks		2 cold eggs	2 cold eggs	
18	adult+ 2 eggs	adult+ 2 chicks - damp		2 hatched eggshells		May 17
19	3 cold eggs	adult+ 3 eggs		adult+ 3 eggs	3 cold eggs	
20	adult+1 egg	adult+ 1 egg no cracks		1 cold egg	hatched eggshell	June 1-6
21	adult+ 2 eggs	adult+ 2 chicks - dry		2 hatched eggshells		May 15
22	1 cold egg	2 cold eggs		2 cold eggs	2 cold eggs	
23	adult+ 2 eggs	adult+ 2 eggs		adult+ 2 chicks	2 hatched eggshells	May 25
24		adult+ 2 eggs		hatched egg-shell fragments		May 18-25
25		adult+ 1 egg cracking		hatched eggshell membrane shreds		May 20-21
26		adult+ 2 eggs pipped		2 hatched eggshells		May 18

Table EM580-7. Clutch size and reproductive success of Ancient Murrelets on Lyell Island in 1982.

Clutch size	Total pairs	Percentage of total	Young hatched	1 hatched 1 infertile	Still incubating	Never incubated	Not incubated then depredated	deserted	total
1	5	2	3			2			5
2	19	76	13	1	1	1	2	1	19
3	1	4						1	1
Total	25		16	1	1	3	2	2	25

Total clutches	25
Successful clutches	17 - 68%
Total eggs laid	46
No. of eggs hatched	30 - 65%

Nocturnal activity on the nesting slopes. A marked difference was noted in the times the murrelets arrived on the slopes on 24 April, during early egg-laying, and on 8 and 21 May, during mid-incubation and early hatching. On 24 April, when birds were still courting and laying eggs, most birds (77) arrived between 2155 and 2340hrs and only 7 arrived thereafter, with the last one flying into the colony at 0120hrs. In contrast, on 8 and 21 May, birds were flying in at a fairly regular rate from 2215 to 0200hrs.

Most birds departed between 0100 and 0300hrs. Arrival and departure were distinct on 24 April, whereas on later nights there was considerable overlap in the times of arrival and departure (Table EM580-8).

The amount and times of vocalization were also different on 24 April. On 24 April there was much vocalization early in the night, quieting down after 0100hrs, whereas on 8 and 21 May, vocalizations were abundant until the last birds left the nesting slope near dawn. Seven chicks were heard leaving the burrows between 2258 and 2352hrs on 21 May. Adults could be heard calling them.

Table EM580-8. Observations made on night watches on Lyell Island in 1982.

Period Begins (PST)	24 April			7 May			8 May			21 May		
	Calls	Arrive	Depart	Calls	Arrive	Depart	Calls	Arrive	Depart	Calls	Arrive	Depart
2130				0	3							
2135					4							
2200	many	some					0	1				
2205	many	25		1*	1		155*	34	3	4*	7	
2230				1			76	7		10**	7	1
2235	many	25	1	6	1		many	24		many	8	
2300				2			70	4		115**	6	
2305	many	27		8				10	1		7	1
2330				0			79	5		120**	5	2
2335	many	1		4				12	1	some	6	1
2400				2			55	4		136	2	
2405	less	4		4			many	6	2	0	14	1
2430				0			58	4	2	69	0	
2435			1					4	1		8	
0100				0			76	4		119	2	1
0105		2	1					9	1		9	
0130			1	0			91	1	2	59	1	2
0135			4	12				2	5		7	12
0200	few		3	2			96		3	40	1	3
0205			8	10					5		2	8
0230	some		2	0t			82	1	7	31		1
0235	less		6							0		11
0300							86t		3	0		3
0305	0		4							0		4
0330	few		6							0t		0
0335	0		16									
0400	0t											

* calling began at 2202 on 7 May, 2206 on 8 May, and 2228 on 21 May.
** on 21 May, 1 nestling called at 2248 and 3 between 2300 and 2305, an adult with young was heard at 2352.
t indicates the end of the observation period.

Staging area. Main concentrations of Ancient Murrelets occurred 2 to 6km off the east side of Lyell Island between Fuller Point and Dodge Point (Fig. EM-2). The maximum number of Ancient Murrelets seen in this area on a single transect was 941 on 8 June. The size of groups varied from 2 to 200 birds. Fewer birds were counted on 13 and 20 May and 23 April (Table EM580-9).

Small numbers of Ancient Murrelets were seen outside of this main staging area. Three sightings were made in the area 3 to 5km north of Dodge Point (maximum=16). Small groups were seen further offshore than the main staging area. One group of 20 Ancient Murrelets was seen 9km east of Fuller Point.

Small numbers (20) of Rhinoceros Auklets and Cassin's Auklets were regularly seen around the staging area. Other sightings offshore included Sooty Shearwater, Parasitic Jaeger, Pigeon Guillemot, Glaucous-winged Gull, Marbled Murrelet, and Pacific Loon.

Table EM580-9. Observations made along water transects off Lyell Island in 1982.

Date	Location and direction of travel	Time	Number of ANMU seen
23 April	Camp Pt. N of 1km	2025	0
	turn E to 3km E of Dodge Pt.	2113	0
	turn SW to Dodge Pt.	2124	0
3 May	From S end of Titul I. E for 9km	2100	16
	turn SW to Camp Pt.	2130	3
12 May	Camp Pt. to E piont of Kunga I.	2130	0
	turn E to Nob Rock		0
	turn S to Camp Pt.	2200	0
13 May	Murrelet Pt. E for 11km	2145	661
	turn S for 3km	2207	20
	turn E to Fuller Pt.	2215	20
20 May	Skaga I., NNW for 3km	2154	0
	turn E for 2km	2206	171
	turn N for 3km	2222	120
23 May	Lost Is. to Camp Pt.	2130	9
8 June	2km S of Dodge Pt., E for 4km	2238	360
	turn N for 3km	2330	581

Predation: Signs of predation on Ancient Murrelets were encountered throughout the colony with the majority in the densest nesting areas (Table EM580-10). The total number of remains of adult birds (carcasses, wings, and feather piles) found within 221 quadrats (5525m^2) was 12 (Table EM580-11). Counting only carcasses and sets of wings (7), yields a conservative estimate of 1,594 Ancient Murrelets preyed upon on the colony in the 1982 season. A similar calculation for depredated eggshells (16 in quadrats) and chicks (2) gives estimates of 3,648 eggs and 455 chicks preyed upon on the colony this season. Remains of depredated birds were also found at plucking sites and other locations outside the colony area.

Bald Eagles and Peregrine Falcons are presumed to be the major predators on Lyell Island. At one Peregrine Falcon plucking site, we found 7 pairs of Ancient Murrelet wings with attached sternum and one freshly decapitated adult Ancient Murrelet. The attached wings and sternum and a pile of feathers of an Ancient Murrelet were found near the base of the Bald Eagle nest 5. River otters may be incidental predators. One scat found contained feathers. Signs of rats were frequently encountered and we suspected that they were responsible for caches of eggshells we found beneath tree bases or stumps as well as for 4 Ancient Murrelet carcasses that had been chewed only around the chest and neck.

Very old skulls and bones of Ancient Murrelets were found throughout the colony, and occasionally some bones such as the sternum were found within the nest cavity of active burrows.

Table EM580-10. Depredated remains of Ancient Murrelets observed within a 5m strip along transects on Lyell Island in 1982.

Transect	Eggs	Chick remains	feather pile	single wing	pair wings	carcass	BAEA pellet	PEFA Pellet
2	8							
4	1	1						
7	1					1		
8	6	1	1	2	1	3		
9	4		1		1	1		
10	4		2		1			
11	6				1	1	1	
12							1	
14	1							
16	5				1			
17	5							
18				1				
19			3			1		
20	1	1	1					
21	2						1	6
22						1		
23	1							
25							1	
TOTALS	45	3	8	3	5	8	4	6

Table EM580-11. Depredated remains of Ancient Murrelets in 5mx5m plots along transects on Lyell Island in 1982.

Transect	Plot #	Depredated egg	chick	Feather pile	Single wing	Pair of wings	Adult carcass
4	6	1					
8	2		1				
8	3					1	
8	4				1		
8	7	3					
8	13				1		
9	4						1
9	6					1	
10	5			1			
10	12	1					
11	3	1					
11	4	1					
14	16	1					
16	6	2					
16	7	1					
17	8	2					
17	15	1					
18	7				1		
19	7			1			
19	8			1			
19	9			1			
19	13						1
20	5	1	1				
21	14	1					
22	7						1
TOTALS		16	2	4	3	2	3

Effects of logging. The western portion of the Ancient Murrelet colony has been encroached upon by clear-cut logging (Fig. EM580-1). Logging destroys the open forest habitat utilized by the Ancient Murrelets both in the actual clear-cut, and subsequently through the action of slides and windfalls initiated from the edge of the slash.

The area of the colony along transect 2 was in closest proximity to the edge of logging. On this transect the edge of logging was at an elevation of 166m. Burrowing extended up to 112m elevation. Just adjacent to the transect a large slide and windfall swath extended 140m down the slope to 99m elevation. This indicates that this slide probably destroyed habitat recently used by the murrelets. On transect 1, windfall and slides extended down the slope to 40m elevation, destroying a large band of forest over 100m wide. These windfall areas and the logging slash above transects 1 and 2 were explored for burrows but no signs were found.

The above observations suggest that clear-cut logging on slopes above

murrelet nesting habitat threatens the birds' habitat through extensive downhill erosion. The nesting population of Ancient Murrelets in this area is presently threatened by further erosion resulting from logging.

Associated species:

Bald Eagle - A total of seven active and one inactive eagle nests were found on the east side of Lyell Island from Powrivco Bay to the east entrance of Faraday Passage (Fig. EM580-1). They have been numbered consecutively from Powrivco Bay to the southeast end. Nest number five, east of Dodge Point, is the only nest in which contents were determined, and the progress of young was observed (see notes below).

1. On W point of large bay midway between Camp Peninsula and Powrivco Bay. The nest of sticks was 25m high in 35m spruce, 10m from shore. At 2000 hrs on 18 May an adult was on the nest.

2. On the first point west of Camp Peninsula. The nest of sticks was 20m high in 30m spruce, 5m from shore. Two adults flew over at 1700 hrs on 22 April. On 19, 20 and 22 May an adult was on the nest.

3. Between Camp Peninsula and Dodge Point. Inactive.

4. At Dodge Point. Nest was 40m high on a leaning branch 7m from trunk of 55m spruce, on rocky knoll 50m from shore. An adult eagle was frequently observed on the nest between 5 May and 9 June.

5. Bay E of Dodge Point in middle of bay, 55m from west end. The nest of sticks was lined with moss and was 30m high in 45m spruce, 4m from shore. This nest could be observed from the top of the slope to the SW. Adults were observed in the nest from 23 April to 9 June. Two chicks were first sighted on 22 May, and their wings were starting to feather on 7 June.

6. On promontory N of small bay just N of Fuller Point, 20m high in 35m spruce, 8m from shore. adult on nest on 1 and 10 May.

7. Just north of island on N side of Windy Bay, 20m high in 35m spruce, 5m from shore. An adult on the nest on 25 April.

8. Between Gates Creek Bay and Faraday Passage, due W of middle of Kawas Islands (at S end of logging slash), 20m high in 30m spruce, 3m from shore. One adult was on nest, 1 adult circling above on 10 May.

Resident Bald Eagles were seen daily in the vicinity of nests as well as offshore when they were fishing. One immature eagle was regularly seen in the vicinity of nest 5.

There was a major influx of non-resident eagles, both adults and immatures, on 17 May. On the NE coast of Lyell, from Powrivco Bay to Fuller Point, a total of 30 eagles were seen on 17 and 18 May. The maximum number of immatures seen was 13 (17 May) and the maximum number of adults seen was 20 (18 May). The eagles were concentrated around Dodge Point where groups were seen feeding offshore on herring boils as well as perched in trees along the shore. Smaller groups of non-resident eagles were present in the area until

the end of May (16 on 27 May). No non-resident eagles were seen 6 to 10 June. (No observations were made 28 May to 5 June or after 10 June).

Peregrine Falcon - Two active Peregrine Falcon eyries were found on the NE coast of Lyell Island. At only one was the nest actually located and the contents determined.

Red-tailed Hawk - First seen on 23 May with 3 subsequent sightings. One sighting was just north of Fuller Point (3 km south of Dodge Point). Two sightings occurred around and west of Dodge Point, and a final sighting on 6 June at camp.

Glaucous-winged Gull - Usually two to eight birds, and up to a maximum of 25 were seen at the north end of the island. They were mostly adults and were last seen on 6 May.

Common Murre - Two birds were seen on 3 May in the Ancient Murrelet staging area.

Rhinoceros Auklet - A few seen in the murrelet staging area off the east coast of Lyell Island, in the late evening. A maximum of 49 were seen on 8 June. Ten of these were perched on drift logs.

Cassin's Auklet - A few birds seen in the Ancient Murrelet staging area.

Marbled Murrelets - Up to 9 birds were seen daily off the north end of the island. On 25 April some were still molting. On 10 May one molting bird and one in winter plumage were seen.

Some interesting observations were made further south in the bay at the mouth of Gates Creek in Gogit Passage. Large numbers of Marbled Murrelets were seen to concentrate in the bay on every occasion that we were in the area. The murrelets were seen at all times of the day in pairs and in groups of up to 20 birds. All were in summer plumage. The sightings are listed below.

10 May - 1300hrs - 158
18 May - 1800hrs - 292
20 May - 2030hrs - 231
28 May - 1800hrs - 56
6 June - 1500hrs - 222 (1 bird in winter plumage)

Alexandrian Rat - Signs of the Alexandrian rat were found throughout the colony area and in other areas of Lyell Island spot checked for murrelet activity. Sign extended from sea level up to at least an elevation of 183 meters. Three rat skeletons and several skulls were found under the bases of trees. There was no indication that there was a larger population of rats in the colony area than anywhere else, since signs and remains of the rats were found in all areas of the colony as well as in parts of Lyell Island where no murrelets were nesting.

Deer Mouse - Signs present throughout colony, and one was seen on a night watch at Dodge Point at 0315hrs.

Sitka Deer - Deer sign was abundant throughout the colony and several skeletons were found. One young deer was seen around camp regularly.

River Otter - One was seen swimming in the bay on the east side of Dodge Point, and on two occasions one was seen swimming around the peninsula 1km west of Dodge Point. Otter sign was commonly found on most promontories and rocky points along the shore.

An active river otter den was found just north of Fuller Point at the beginning of Transect 24. Scats contained only fish remains. An adult otter was flushed from the den on 1 May.

What appeared to be a temporary den was located under an old stump at an elevation of 150m at the top of a cliff just south of Dodge Point within a dense part of the murrelet colony. Fresh otter scats, one of which contained feathers, were found all around the site on 26 April. No fresh sign was found on a subsequent visit on 17 May.

Saw-whet Owl - Heard in the forest at night from 20 April to 20 May. One around camp and one around Dodge Point.

Northwestern Crow - Two or three were present around camp daily. Ten to sixteen birds were seen along the beach on the east coast, in the murrelet colony.

Common Raven - Present in the colony. Ravens were heard near camp daily, and near Dodge Point. There are probably one or two pairs in this area.

Hair Seal - One regularly sighted around camp, and 1 or 2 sighted periodically on the southeast side.

Fur Seal - One animal was sighted just offshore from Dodge Point on 15 May.

Dall Porpoise - Five animals were sighted off Dodge Point on 13 May.

Remarks: A curious observation was made concerning Varied Thrushes on Lyell Island. A significant number of carcasses were found along the Ancient Murrelet population transects. No remains of any other passerine bird were found. The majority of Varied Thrush remains were found along the east coast of Lyell south to the southern limit of the murrelet colony. Along six of the transects, six carcasses in various stages of decomposition and three piles of thrush feathers were found. One carcass was found tucked under a grass tussock, all the rest were found stuffed under the bases of trees.

EM-620 KUL ROCKS 103 B/12

Location: At mouth of Richardson Inlet, east of Dog Island.

52°44'15"N 131°35'52"W

Land status: Crown land.

Date of visit: 20 June 1986.

Colony access: Drop-off from boat.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Count from boat.

Description: Small rocks.

Nesting species: No Glaucous-winged Gulls were seen.

Black Oystercatcher: 2 adults present.

Pigeon Guillemot: 1 adult present.

Associated species:

Bald Eagle - 1 adult

Northwestern Crow - 15

Hair Seal - 4

EM-640 TITUL ISLAND 103 B/13

Location: South side of Laskeek Bay, north of Kunga Island.

52°47'N 131°34'28"W

Land status: Crown land.

Date of survey: 12 May 1983 (1100-1700 hrs).

Colony access: Landing on west side beach.

Base camp: Not suitable for camping.

Observers: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte.

Census method: Total count.

Description: Titul is a long, narrow, steep-sided island with cliffs overhung by forest along the west side, and steeply rounded rock with grassy fringes at the forest edge on the east side. It has a total area of 7.2ha, with 5.6ha of vegetated habitat, and a maximum elevation of 72m. The forest is a mix of spruce, redcedar, alder, and some willow (Salix sp.) and crabapple, with a ground cover of cow parsnip (Heracleum lanatum), sword fern, mosses, and seedling spruce, as well as some bare areas under thick cedar stands. Elderberry, huckleberry, and currant are abundant above the cliffs along the west side. The south point of the island is an open grassy knob with shallow soil. The limestone rock in this area has been weathered into unique patterns.

Nesting species:

Storm-Petrels: We found 2 petrel-sized burrows, but there was no other evidence of nesting by petrels.

Pigeon Guillemot: We counted 114 around the island at 1100hrs.

Cassin's Auklet: Burrows were predominantly in the grassy fringes along the east side under roots, logs, or into the bank within 20m of the edge. A few burrows were located on the west side near the north end.

Total burrows: 228 counted.

1983 Occupancy rate: No occupancy rate was determined. An adult was pulled from one burrow and a cold egg found in another.

1983 Nesting population: Using the median British Columbia occupancy rate of 75% ,we estimated 170 pairs nesting.

Associated species:

Bald Eagle

Peregrine Falcon

River Otter

Sitka Deer

Location: Laskeek Bay between Dodge Point and Reef Island.

52°48'15"N 131°29'W

Land status: Crown land.

Date of survey: 11 May 1983, 1100-1800hrs (main survey), and 20 June 1986, 1940-2100hrs (gull and oystercatcher count).

Colony access: Drop-off from boat. We did land on a tidal rock shelf on the north end of the main island on a falling tide.

Base camp: Not suitable for camping.

Observers: 1983: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count. The entire perimeter of the island as well as short distances into the salal at various locations was explored. The interior area of dense salal was not checked.

Description: The topography is undulating, with a number of rocky knobs and ridges separated by draws and steep rocky gorges from the main body of the island. There is a separate island at the north end. The island has a total area of 12.7ha, with 5.3ha of vegetated habitat, and rises to a maximum elevation of 53m. Thick salal under a sparse spruce forest covers most of the island. Around the perimeter are a few open fringes of grass, Maianthemum and moss. The southern-most dissected knob has the only significant expanse of open understory. A considerable portion of the island is bare rock, especially on the large southeastern knob and the south point where the gull colony is. These extensive rocky areas have grass and forbs on higher sections. Angelica is abundant. The east point has a group of 10m high spruce.

Nesting species:

Fork-tailed Storm-Petrel: Petrels were burrowing in the open areas around the fringe and on the southern knob mixed with Cassin's Auklets (Fig. EM650-1).

Total burrows: 87 counted.

1983 Occupancy rate: 4 of 4 known. This sample was too small to be certain of its validity, therefore we used the median British Columbia rate of 91% to calculate a nesting population.

1983 Nesting population: 80 pairs estimated.

Leach's Storm-Petrel: We saw no evidence of this species in 1983, but researchers visiting the island on 30 May 1985, heard Leach's Storm-Petrels calling from burrows (Gaston and Noble 1985).

Black Oystercatcher: In 1986, we found the following nests:

Emp	1E	2E	Total
1	1	1	3

Nests were made of rock chips.

Glaucous-winged Gull: In 1983, 150 were standing on territory and roosting. In 1986, we tallied the following nests:

	Start	Emp	1E	2E	3E	2E1Y	1E2Y	2Y	3Y	Total
E point	10	6	3	3	21	1	1	3	1	49
S point	3	3	2	4	14					26
TOTAL	13	9	5	7	35	1	1	3	1	75

Nests were made of grass.

Pigeon Guillemot: In 1983, there were 31 on the water at the north end. In 1986, 6 adults were present. 1 flew out of a crevice.

Cassin's Auklet: Burrows were scattered around the perimeter in the disjunct fringes of grassy habitat (Fig. EM650-1). The majority of the burrows were found in the larger area of open habitat on the southern knob. Burrows on the west side appeared old and unused.

Total burrows: 286 plus 24 old burrows on the west side.

1983 Occupancy rate: 3 of 5 known (too few to give a reliable rate). The 3 occupied burrows held adults incubating eggs.

1983 Nesting population: Using the median British Columbia occupancy rate of 75%, we estimated 210 pairs.

Predation: We found 6 Fork-tailed Storm-Petrel wings, 2 near an otter den.

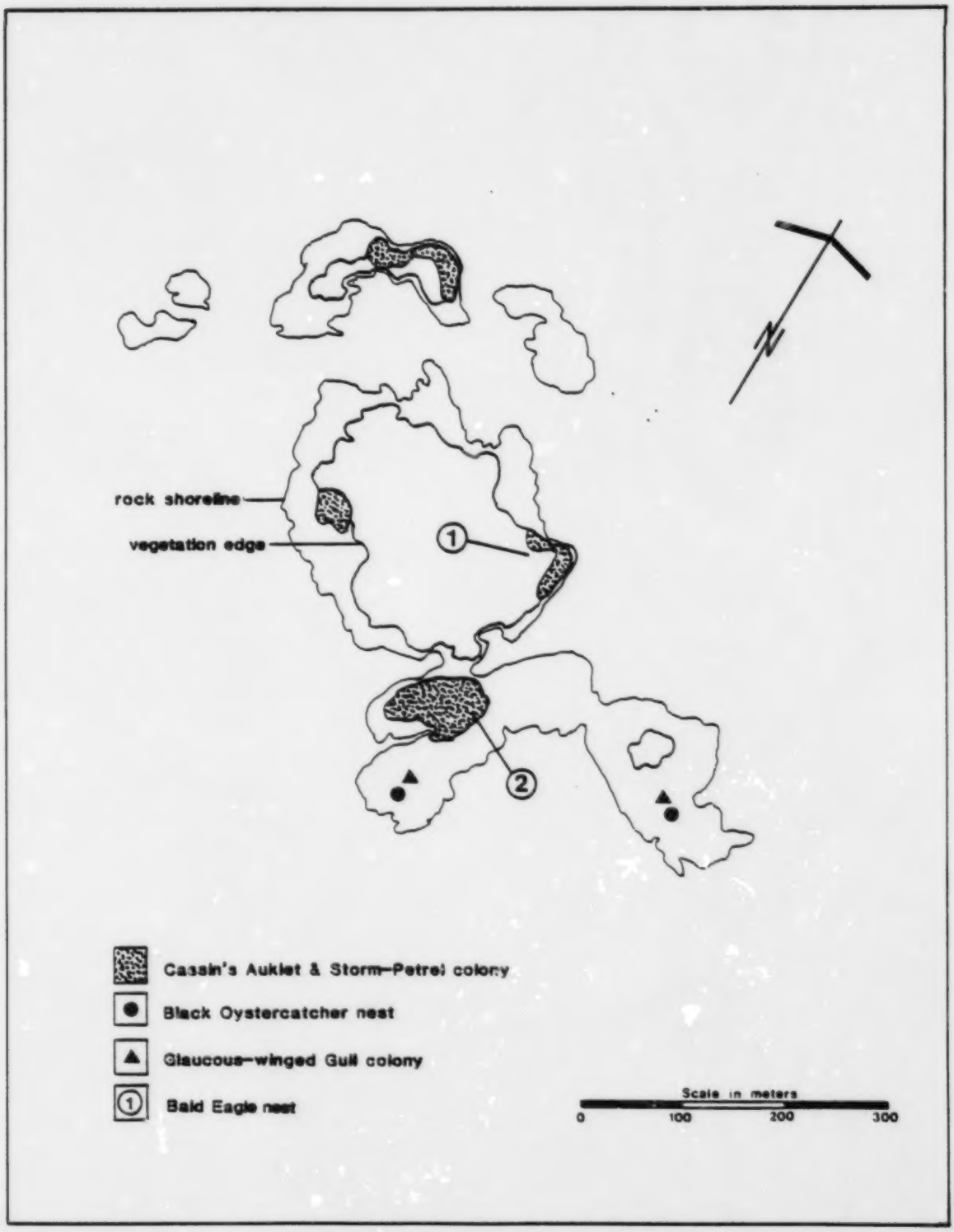

Figure EM650-1. Seabird colony areas on Lost Islands in 1983.

Associated species:

Bald Eagle - 2 nests:

1. On north side of east knob, 6m high in 15m spruce 20m from edge of vegetation. One downy young was visible, more may have been present.

2. On southeast side of the south knob, 10m high in a spruce near the edge of vegetation. Two chicks in nest.

Peregrine Falcon

Black Oystercatcher - 4

Northwestern Crow

Common Raven

Hair Seal - 20

River Otter

EM-660 HELMET ISLAND 103 B/13

Location: At the mouth of Dana Inlet, north of Porter Head.

52°49'N 131°39'30"W

Land status: Crown land.

Date of survey: 13 May 1983 (1518-1619hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Bertram, D. Powell, Y. Turcotte.

Census method: Exploration.

Description: Helmet is a very steep-sided island, with exposed rock or shallow soil on the slopes. It has an area of 10.4ha, and a maximum elevation of 111m. Most of the ground is mossy under a forest of redcedar, spruce, and hemlock, with alder, salal, and huckleberry growing around the edges. Lodgepole Pine occurs along the exposed edges on the east and south sides. The small separated islet on the south side is covered with thick salal under redcedar and spruce.

Nesting species: No sign of burrowing was found.

Pigeon Guillemot: We sighted 19 off the south side around the little island.

Associated species:

Pelagic Cormorant - 1 immature

Bald Eagle - 1 nest

Northwestern Crow

Hair Seal

River Otter

Sitka Deer

EM-680 KINGSWAY ROCK 103 B/13

Location: At the mouth of Selwyn Inlet, east of Haswell Island.

52°51'46"N 131°40'15"W

Land status: Crown land.

Date of visit: 13 May 1983 (1130hrs), and 21 June 1986 (1010-1057hrs).

Colony access: Drop-off from boat.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count in 1986. In 1983, we only boated by the island.

Description: Mostly bare rock with patches of grass and forbs - Achillea, Mimulus, Castilleja unalaschensis, Sedum, Saxifraga, and Fragaria.

Nesting species:

Black Oystercatcher: In 1986 we found 1 nest with 3 eggs. Nest was made of rock chips and shells. There were 4 adults present.

Glaucous-winged Gull: In 1985 we counted 21 adults standing on terrritory. In 1986, we tallied the following nests:

Start	Emp	1E	2E	3E	Total
5	7	3	3	25	43

Four empty nests contained depredated eggs: 3 with 2 eggshells and 1 with 1 eggshell. One nest with 1 egg also contained 1 depredated egg and 1 cracked egg. Nests made of grass; a few with moss and seaweed.

Pigeon Guillemot: There were 34 Pigeon Guillemots on the rocks and water in 1985. In 1986, we counted 72 adults on the shore rock and in the water. We found 3 nests with 1 egg each.

Associated species:

Pelagic Cormorant - 2 immatures.

River Otter - sign on south side of island. There were only 4 gull nests in this area (1/4 of island area). Scats contained fish.

EM-690 REEF ISLAND 103 B/13,14

Location: Laskeek Bay, southeast of Louise Island. 52°52'N 131°31'W

Land status: Provincial Wildlife Management Area.

Date of survey: 16-19 May and 21 May 1983 (Exploration and partial count for storm-petrels and Cassin's Auklets); May-June 1985 (transects for Ancient Murrelets, count of Pigeon Guillemots and Pelagic Cormorants - Gaston and Noble 1985); 31 May 1986 (cormorant count); 20 June 1986, 2130-2138hrs (count of gulls on east rock. The weather was too stormy at this time to allow us to approach the south cliffs to check for cormorants and other nesting gulls).

Colony access: Except at low tides, landing on beaches in chutes on the north side at the east end, in the mid-south bay, and on the south side near the west end. At high tide landing is reasonable on the east side of the mid-north peninsula.

Base camp: A temporary cabin was erected in 1984 by A.J. Gaston of the Canadian Wildlife Service on the peninsula on the mid-north coast. There is some tenting space in this area. Seepage water is collectable.

Special considerations: At time of writing (1988), research is ongoing at this site.

Observers: 1983: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte. 1985: A. Gaston, I. Jones, D. Noble. 1986: A. Gaston (cormorants); M. Rodway, D. Garnier, D. Grinnell (gulls).

Census method: Exploration, partial count (for storm-petrels and Cassin's Auklet), total count (for cormorants, gulls and guillemots), and line transects (for Ancient Murrelets). On the transects, 111 circular plots with areas of $100m^2$, were placed at 30m intervals along 12 parallel transects

spaced at 200m intervals and run on a north-south bearing (see Gaston and Noble 1985 for more detail).

Description: The south side of Reef presents an almost continuous band of cliffs cut by a few steep grassy and mossy slopes with separated knolls and pinnacles rising from their lower reaches. Slopes above these cliffs rise to a maximum elevation of 181m. The north side of the island has fewer cliffs but steep slopes rise directly from the shore. The island has a total area of 249ha.

Sitka Spruce is the dominant tree around most of the island with hemlock and cedar more abundant in the interior. At the tops of some of the cliffs on the south side are open stands of Lodgepole Pine. Salal rimmed a number of cliff tops in this area. At the east end are extensive open grassy knolls with a large area of thickly regenerating young spruce separating them from the open mossy interior forest to the west. On the south side west of the large bay, the forest was of a uniform stand size (20-60cm dbh). Signs of an old fire were observed in this area and along much of the western half of the south side. Toward the east end, in the grassy area, a stand of large spruce were infected with aphids. The needles were turning brown and falling off, and some trees appeared to be dying.

The small islet off the south side towards the east end is mostly dense salal under spruce with some open grassy patches. Smaller rocks off the south side and east end are bare.

Nesting species:

Fork-tailed Storm-Petrel: In 1983, we found petrels only on the islet off the southeast side of the main island, nesting under grass tussocks. Two adults, one incubating, were reached in burrows. No sign of Leach's Storm-Petrel were found but their nesting season had not yet begun.

Total burrows: 150 (41 counted)

1983 Nesting population: We estimated 140 pairs.

Pelagic Cormorant: In 1985, on 13 June, at least 10 pairs were attending nests in rock crevices near the east end of the island. Four appeared to be incubating. Several other pairs were still nest building. On 31 May 1986, 11 nests were counted.

Glaucous-winged Gull: In 1983, there were 6 adults standing on the cliffs towards the west end of the south side. In 1986, we counted the following nests on the rock at the east end:

Start	Empty	2E	Total
1	1	5	7

Pigeon Guillemot: In 1983, we counted a maximum of 167 around the island at the bases of cliffs and rocky slopes. A total of 338 birds were counted around the island on 30 May 1985 at 0700-0730hrs.

Ancient Murrelet: Along the north side burrowing occurred over a large continuous area (Fig. EM690-1), primarily on seaward facing slopes as steep as 60° (averaging 15° to 47°; Table EM690-1), in open mossy or bare areas around the roots of spruce, hemlock and cedar. A few burrows were located in grassy areas mixed with Cassin's Auklets, some under thick young spruce, and some on open slopes that faced inland. Burrowing extended from shore, where the ground was bare or mossy, to the ridge top as far as 315m from shore. The density of burrows was highest near the ridge tops where the slopes rounded off.

Table EM690-1. Extent of Ancient Murrelet colony along transects on Reef Island in 1985 (from Gaston and Noble 1985).

Transect	Slope (0° from horizon)	Distance to end of occupied area (m) Measured	On map
2	18	225	214
3	47	105	72
4	36	75	61
5	30	225	195
6	27	285	254
7	28	165	146
8	40	135	103
9	37	165	132
10	37	195	156
11	15	315	304
12	17	105	100

* No burrows were found on transect 1.

On the south side burrowing was sparse and sporadic around tree roots, deadfall, and in rock crevices on the grassy slopes and knolls. Denser pockets occurred in the open bare and mossy forest above the cliffs to an elevation of 120m.

Number of sample plots: 72 (0.72ha - 1.8% of colony).

Average Density: 199 ± 30 burrows/ha (standard error calculated from data in Table EM690-2).

Colony Area: 39.5ha (Gaston and Noble 1985). From the 1983 exploration, we estimated the colony area to be 38.6ha, 31.6ha on the north slope, and 7.0ha on the south slope.

Total Burrows: 7845 ± 1185

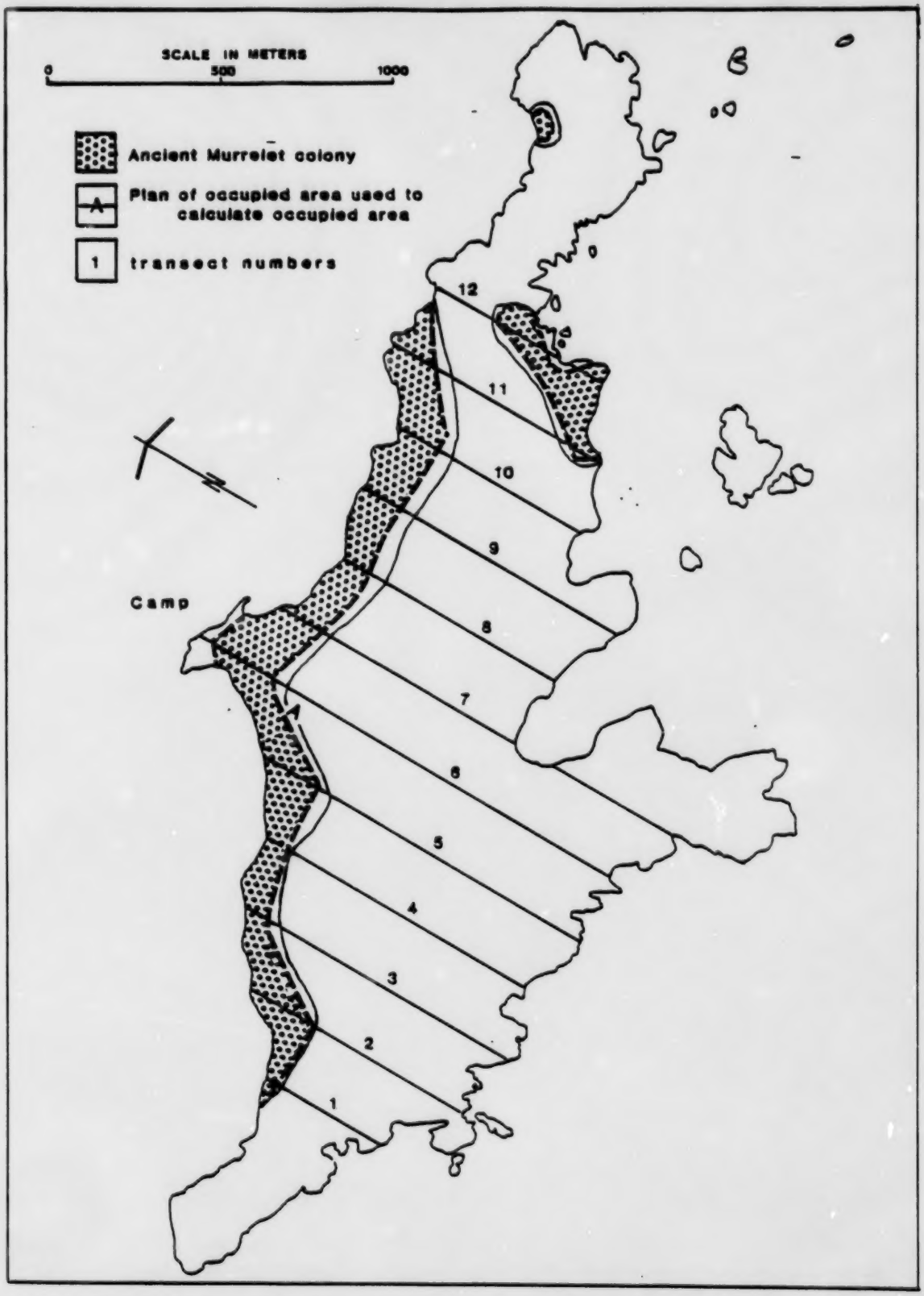

Figure EM690-1. Ancient Murrelet colony and transect locations on Reef Island in 1985 (from Gaston and Noble 1985).

1985 Occupancy Rate: 37 of 59 known, or 63%. In 1983 we determined the contents of 10 burrows, all of which were occupied.

1985 Nesting Population: 4942 ± 747 rounded to 5000 pairs in Gaston and Noble 1985.

Table EM690-2. Distribution of numbers of Ancient Murrelet burrows found per plot in the course of the census on Reef Island in 1985 (from Gaston and Noble 1985).

Burrows per plot	0	1	2	3	4	5	6	7	8	9	10	11	12
Number of plots	26	16	9	6	5	3	3	1	0	1	1	0	1

Cassin's Auklet: Burrowing occurred in disjunct patches all around the perimeter of the island (Fig. EM690-2) in grassy slopes and knolls, rock jumbles, and under roots. Most of the colony area was under spruce, with some hemlock occurring where burrows extended further inland. We found some burrows in the open stand of Lodgepole Pine on the cliff top on the east side of the large, mid-south bay. Burrows were recorded from sea level to as high as 92m in areas above the cliffs. We also found Cassin's Auklets nesting on the small islet off the southeast side.

Burrows counted and estimated: 1,799 in a combined area of 3.4ha (Table EM690-3).

Colony area: 6.2ha

Total burrows estimated: 2320

1983 Occupancy rate: 6 of 6 known (too few to be confident of the rate). Of these 6 burrows, 1 held an adult, one a chick and the rest contained an adult incubating an egg.

1983 Nesting population: We estimated 1700 pairs (using the median British Columbia occupancy rate of 75%).

Predation: Evidence of predation on Ancient Murrelets (67 feather piles, 14 pairs of attached wings, 3 carcasses, and 16 eggshells) and Cassin's Auklets (12 feather piles, 7 wings, 1 carcass, and 2 eggshells) was frequently encountered. One Cassin's Auklet burrow was dug up, probably by river otter. We suspected that the major predators were Bald Eagles and Peregrine Falcons.

A number of Fork-tailed Storm-Petrel wings and feather piles were found on the small island off the southeast side where the petrels were nesting.

Associated species: (1983)

Bald Eagle - 6 nests were located (Fig. EM690-2):

1. 30m high near top of large, dead spruce, at 37m elevation. Adult and one chick in nest and another adult defending nest on 19 May.

2. 20m high in 65m tree, 30m from shore. Adult on nest and another nearby on 18 May.

3. 20m high in 28m spruce 20m from top edge of cliff. No adults present on 16 May.

4. in spruce 300m from shore.

5. 25m high in 35m spruce 15m from shore. No adults present on 19 May.

6. on small islet off SE side; at the top of an 18m high spruce, at the top of a cliff above the shore.

Maximum number of eagles seen was 2 adults, 4 subadults and 4 immatures on 21 May.

Peregrine Falcon - 2 eyries suspected

Black Oystercatcher - 2

Northwestern Crow

Common Raven - nest suspected on a cliff-ledge on the southwest side of the island. No activity.

Hair Seals - 7

Northern Sea-lion - 136+ on southeast rocks on 17 May.

River Otter - 1 seen; 4 dens. Most scats contained fish remains, a few contained feathers.

Sitka Deer

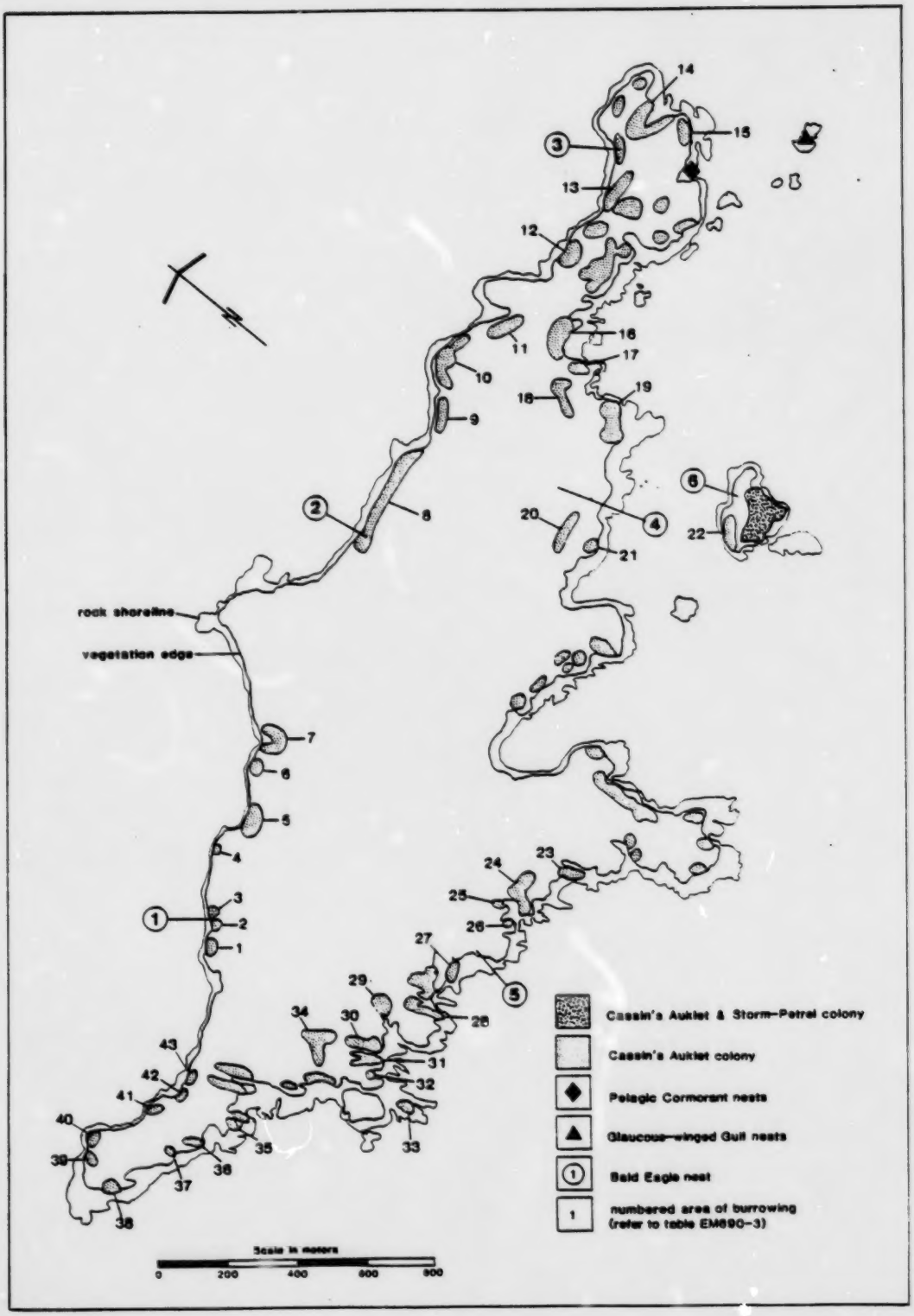

Figure EM690-2. Seabird colony areas (other than Ancient Murrelets) on Reef Island in 1983.

Table EM690-3. Counts of Cassin's Auklet burrows around Reef Island in 1983.

Section	Numbered area on Fig. EM690-2	Number of burrows: Total count	Number of burrows: Partial count	Number of burrows: Estimated total for section
A	West half of north coast			
	1	35		
	2	15		
	3	14		
	4	6		
	5		20+	
	6		25+	
	7	77		
A				185
B	East half of north coast			
	8		30+	
	9	30		
	10	53		
	11	35		
B				150
C	East end			
	12		10+	
	13		80	
	14		60	
	15		30	
C				400
D	East half of south coast (to east side of large south bay)			
	16		20	
	17	48		
	18	86		
	19		280	
	20	48		
	21	17		
D				535
E	Islet off the south-east coast			
	22	36		
E				60
F	South-west coast (from west side of large south bay to south side of west beach)			
	23	37		
	24		51+	
	25	6		
	26	3		
	27		102+	
	28	38		
	29		36+	
	30	55		

Table EM690-3 cont'd

Section	Numbered area on Fig. EM690-2	Number of burrows: Total count	Number of burrows: Partial count	Number of burrows: Estimated total for section
F	31	53		
	32	8		
	33		140	
	34		78+	
F				800
G	Western end of Reef Island (from west beach)			
	35		20+	
	36	13		
	37	11		
	38	31		
	39	3		
	40	7		
	41	14		
	42	8		
	43	30		
G				190
TOTALS		817	982	2320

Location: East of Vertical Point on Louise Island, northwest of Reef Island.

52°53'45"N 131°34'20"W

Land status: Crown land.

Date of survey: 7 May 1983 (exploration), and 21 June 1986, 1136hrs (Circumnavigated by boat).

Colony access: In calm weather landing is feasible on the north side.

Observers: 1983: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Exploration.

Description: South Low is a flatish island with small rocky knolls. It has an area of 13.3ha. A thick underbrush of salal, thimble berry (Rubus parviflorus), and saskatoon-berry (Amelanchier florida) occurs under spruce, alder and willow. Small crabapple, wild rose, and twinberry grow around the edges, and luxuriant patches of forbs occur in shallow soil on the south side.

Nesting species: Three old Cassin's Auklet burrows were found on the narrow isthmus in the middle of the island. We found no current sign of burrow nesting by seabirds.

Black Oystercatcher: In 1983, we found 1 empty scrape on the west point. Two adults were present. There was one pair on the northeast point in 1986.

Pigeon Guillemot: In 1986, there were 18 off the east end.

Associated species:

Bald Eagle - 1 empty and 1 old nest. 14 circling

Glaucous-winged Gull - 4 (There were no gulls present in 1986.)

Northwestern Crow - 3

Hair Seal - 3

EM-710 VERTICAL POINT CLIFFS 103 B/13

Location: On the southeast side of Louise Island. 52°54'10"N 131°37'30"W

Land status: Crown land.

Date of survey: 24 April - 23 May 1983, and 21 June 1986, 1123hrs.

Colony access: Cliffs are surveyed by boat. Sheltered landing in bay west of cliffs.

Base camp: The bay west of the cliffs provides an excellent base camp. We surveyed all islands in this area from this camp.

Observers: 1983: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: We only explored the forested habitat on Vertical Point, and surveyed the cliffs on the south side of the point by boat.

Description: There are limestone cliffs rising to about 25m on south side of the point. The forested area on Vertical Point has some open interior habitat.

Nesting species: We saw no cormorants around the cliffs on Vertical Point on any of our visits. There was no evidence of nesting by seabirds in the forested habitat.

Pigeon Guillemot: We sighted a maximum of 7 birds in 1983, on the rocks and water at the base of the cliffs. There was 1 bird present in 1986.

Associated species:

We saw racoon, Black Bear, Sitka Deer, and squirrels in the area.

Location: Northeast of Vertical Point on Louise Island.

52°54'30"N 131°37'W

Land status: Provincial Wildlife Management Area.

Date of survey: 28-30 April and 2-7 May 1983.

Colony access: Landings in bays on west side of east island and on south end of west island.

Base camp: Camping possible in both the above landing bays, though we used Vertical Point as our base. Water was not evident during our exploration.

Observers: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte.

EAST ISLAND

Census method: 113 quadrats (5mx5m) surveyed at 20m intervals along 14 transects spaced 100m apart along the shore (Fig. EM720-1).

Description: The east island has an area of 48ha, and rises to an elevation of about 60m. The topography consists of a series of ridges with some steep slopes and cliffs towards the shore. The eroded limestone has formed crevices and sinkholes over much of the island. Along the west, north and east sides the forest is mostly redcedar mixed with varying amounts of spruce. Hemlock becomes more abundant in interior areas, and Red and Sitka Alder occur in some of the valleys near shore. The ground is mainly open and bare under redcedar, with more moss under spruce, hemlock and alder. Along the south side is an old burn with areas of thickly regenerating spruce and some larger alder stands. A recent windfall swath cuts up from the south side to the crest of the island.

Nesting species:

Pigeon Guillemot: A group of 65 were counted on the west side of the east island on the rocks and in the water. Two empty burrows with broken eggshells were located at the edge of the vegetation. We also suspected that Pigeon Guillemots were nesting in crevices on the edge of the promontories on the southeast end.

Ancient Murrelet: Burrowing occurred around live and dead tree roots and in rock crevices over most of the northern half of the island (Fig. EM720-1; Table EM720-2). Burrowing extends as far as 250m from shore and to the high point of the island on slopes averaging 4° to 29° (Table EM720-1). Most occupied burrows held adults incubating eggs, though a number of single cold eggs were found (Table EM720-4). The mean length of 26 burrows whose ends were reached was 77 $\pm$ 8cm.

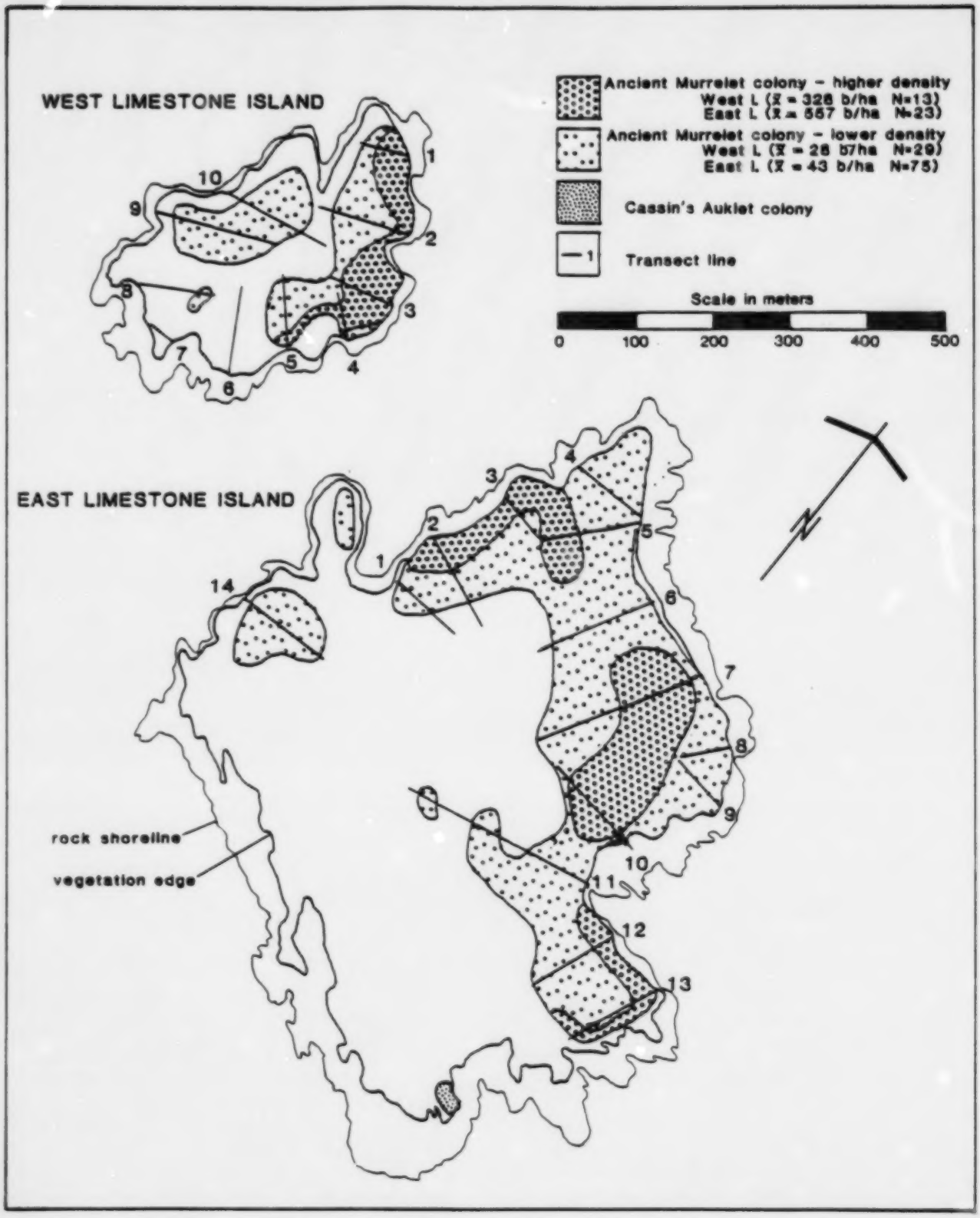
WEST LIMESTONE ISLAND
Ancient Murrelet colony - higher density
West L (x̄ = 328 b/ha N=13)
East L (x̄ = 557 b/ha N=23)
Ancient Murrelet colony - lower density
West L (x̄ = 28 57ha N=29)
East L (x̄ = 43 b/ha N=75)
Cassin's Auklet colony
Transect line
Scale in meters
0 100 200 300 400 500
EAST LIMESTONE ISLAND
rock shoreline
vegetation edge

Figure EM720-1. Seabird colony areas and transect locations on Limestone Islands in 1983.

Table EM720-1. Transect parameters and extent of Ancient Murrelet colony on east Limestone Island in 1983.

Transect parameters								Extent of colony			
Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max. (m)	Average slope (°)	Range of slopes (°)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevations (m)
1	95	105	2	24	24	14	4-32	0-70	0	70	2-21
2	114	145	11	20	28	20	0-80	0-110	0	110	11-28
3	100	85	5	20	25	13	5-34	0-85	0	85	5-25
4	90	173	4	3	20	21	3-45	0-173	0	80	3-20
5	221	145	2	27	27	12	3-26	0-145	0	70	2-27
6	210	185	1	31	31	8	1-21	10-150	10	150	2-29
7	210	205	2	29	30	12	0-30	0-205	0	170	2-30
8	220	105	7	23	25	14	5-35	0-105	0	105	7-25
9	280	85	12	22	22	4	0-5	0-85	0	85	12-22
10	280	165	3	27	27	11	5-20	0-165	0	165	3-27
11	260	265	1	26	34	12	2-35	0-90 130-190 230-250	0	250	1-34
12	200	125	6	38	55	26	16-35	0-110	0	95	6-55
13	200	145	5	25	42	29	6-60	0-130	0	35	5-42
14	90	147	12	2	25	16	10-45	10-147	10	110	2-25

Table EM720-2. Habitat locations of Ancient Murrelet burrow entrances along transects on east and west Limestone islands in 1983.

Habitat locations	East Limestone		West Limestone	
	Number of burrows	Percent of total	Number of burrows	Percent of total
Tree base	6	15	6	24
Live tree roots	9	23	4	16
Stump	1	3	-	-
Dead tree roots	2	5	2	8
Log	3	8	9	36
Rock	15	38	3	12
Open ground	4	10	1	4
TOTALS	40		25	

Number of sample plots: Higher density: 23
Lower density: 75
Overall: 98 (2450m^2 - 1.7% of colony)

Average Density: Higher density: 557 ± 74 burrows/ha
Lower density: 43 ± 16 burrows/ha
Overall: 160 ± 30 burrows/ha (Table EM720-3)

Colony area: 14.9 ha

Total burrows: 2376 ± 446

1983 Occupancy rate: 61.0 ± 5.9% (49 of 80 known)

1983 Nesting population: 1449 ± 305 pairs

Cassin's Auklet: Burrows were found on the southeast end of the island on rocky knolls and promontories near shore. Burrows were located under tree roots and grass tussocks. One adult incubating an egg was pulled.

Total burrows: 50 (Total count)

1983 Nesting Population: We estimated 40 pairs nesting.

Rhinoceros Auklet: On the high point of the island towards the east end we encountered 2 large burrows with large yellow and black fecal droppings. We could not reach the end of these burrows, but they were similar in appearance to typical Rhinoceros Auklet burrows. No further evidence was obtained.

Table EM720-3. Number of Ancient Murrelet burrows in 5mx5m plots on east Limestone Island in 1983. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Transect	Plot													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1	0	0	0	–	–								
2	**1**	**2**	**2**	0	0	0	–	–						
3	**2**	**2**	0	0	0									
4	0	0	0	0	0	1	0	0	0					
5		1	0	1	0	**0**	**1**	**2**						
6	–	0	0	0	1	0	0	0	–	–				
7	0	**3**	**1**	**1**	**2**	**1**	0	0	0	0	1			
8	0	0	0	0	0	0								
9	0	0	0	0	0									
10	0	0	**1**	**0**	**1**	**0**	**1**	0	0					
11	0	0	2	0	0	–	–	0	0	0	–	–	0	–
12	**2**	**2**	0	0	0	0	–							
13	**2**	**0**	0	0	0	0	**3**	–						
14	–	0	0	0	0	0	0	0						

Table EM720-4. Occupancy of Ancient Murrelet burrows along transects on east Limestone Island in 1983.

Date	Transect	Plot	Burrow contents						Total occupied	Total known
			Empty	1 cold egg	2 cold eggs	Dead Adult	Adult+ 1 egg	Adult+ 2 eggs		
30/04	1	3	1						0	1
30/04	2	3	1						0	1
30/04	2	4		1					1	1
30/04	2	6						1	1	1
2/05	3	1	2						0	2
2/05	3	5		1					1	1
2/05	4	2						2	2	2
2/05	4	4	1		1			1	2	3
2/05	4	6						1	1	1
2/05	5	2	3	1					1	4
2/05	5	4		2					2	2
2/05	5	5						2	2	2
2/05	5	6	1						0	1
3/05	5	8	3						0	3
2/05	6	5	1						0	1
2/05	6	6		1				1	2	2
3/05	7	3	1						0	1
3/05	7	5	1						0	1
3/05	7	6	2					2	2	4
3/05	7	9						1	1	1
3/05	7	10	2						0	2
3/05	8	2		1					1	1
3/05	8	3						1	1	1
3/05	9	3		2					2	2
3/05	9	5						1	1	1
3/05	10	2		1					1	1
4/05	10	3	1					1	1	2
4/05	10	4	2						0	2
4/05	10	5						1	1	1
4/05	10	6	1						0	1
4/05	10	7	1		1			1	2	3
4/05	10	8	1					2	2	3
4/05	10	9		1			1	1	3	3
4/05	12	1	1	1					1	2
4/05	12	2						2	2	2
4/05	12	6						1	1	1
4/05	13	1	1					1	1	2
4/05	13	4	1						0	1
4/05	13	5						1	1	1
4/05	13	6						1	1	1
4/05	13	7	2	1		1		4	6	8
5/05	14	2	1					1	1	2
5/05	14	3						1	1	1
5/05	14	7						1	1	1
TOTALS			31	13	2	1	1	32	49	80

Predation: There was considerable predation on the Ancient Murrelets on the east island (28 feather piles, 7 connected pairs of wings, 4 single wings, and 41 eggshells), though not as heavy as on the west island (see west island). Depredated remains found in plots along transects are shown in Table EM720-5. Using the number of feather piles and the number of eggshells yields estimates of 16 ± 8 feather piles/ha and 33 ± 11 depredated eggs/ha, giving total estimates of 242 ± 119 birds and 486 ± 165 eggs preyed upon on the colony up to the time of our survey.

Most predation was suspected to be by Bald Eagles. We found 7 pellets that contained feathers. We also found remains of a crow, and an eagle pellet with a gull bill and feathers. Three burrows were partially dug up and a few river otter scats contained feathers.

Table EM720-5. Depredated remains of Ancient Murrelets in 5mx5m plots along transects on east Limestone Island in 1983.

Transect	Plot	Feather pile	Single wing	Pair of wings	Depredated egg
1	1				1
1	4		1		
2	7				1
3	1				1
5	2	1			
6	2				1
6	7				1
6	8			1	
7	1	1			
9	1	1			
10	6				1
11	3				1
11	4	1			
14	5				1
TOTALS		4	1	1	8

WEST ISLAND

Census methods: 62 quadrats (7mx7m) spaced 20m apart along 10 transects begun at 100m intervals along the shore (Fig. EM720-1).

Description: The west island has an area of 16ha, and rises to a maximum elevation of 45m. The topography consists of rocky ridges cut by steep gullies. The ground is open under a forest of cedar and spruce with some alder and hemlock.

Nesting species:

Ancient Murrelet: Burrowing was sparse and sporadic over most of the island, with an area of higher density burrows on the northeast side (Fig. EM720-1; Table EM720-6). Burrows were located under tree roots, stumps and logs (Table EM720-2), on slopes averaging 11° to 31°. Most burrows explored were empty (Table EM720-8). The mean length of 13 burrows whose ends were reached was 65 ± 6cm.

Number of sample plots:	Higher density:	13
	Lower density:	29
	Overall:	42 (2058m^2 - 4.7% of colony)
Average Density:	Higher density:	328 ± 68 burrows/ha
	Lower denisty:	28 ± 13 burrows/ha
	Overall	120 ± 30 burrows/ha (Table EM720-7)
Colony Area:	4.4 ha	
Total Burrows:	530 ± 133	
1983 Occupancy Rate:	20.0 ± 8.4% (8 of 40)	
1983 Nesting Population:	106 ± 50 pairs	

Predation: There was heavy predation on Ancient Murrelets on the west island. On our exploration we found 71 feather piles, 5 connected pairs of wings, 11 separate wings, 1 carcass, and 24 eggshells). Along our transects, evidence of predation was continuous. Feather piles and eggshells found within plots (Table EM720-9) yielded estimates of 44 ± 18 feather piles/ha and 24 ± 12 eggshells/ha, giving total estimates of 194 ± 80 Ancient Murrelets and 106 ± 53 eggs that had been preyed upon on the colony up until the time of our survey.

Bald Eagles were thought to be the main predators (24 pellets of feathers) though a mammalian predator was also suspected. Nine burrows had been dug up, at one of which we found the head and an eggshell of a Ancient Murrelet. A few feathers were found in river otter scats. We observed two scats of uncertain identity along transects. They were not like typical river otter or racoon, but with the close proximity of this island to the main shore of Louise Island where racoon were frequently sighted, we wondered if these scats might indicate the presence of this species. Further investigations should be conducted to determine the cause of the high level of predation and low occupancy rate observed on this island.

Table EM720-6. Transect parameters and extent of Ancient Murrelet colony on west Limestone Island in 1983.

Transect parameters								Extent of colony			
Transect	Bearing (°)	Total length (m)	Elevation Beg. (m)	Elevation End (m)	Elevation Max. (m)	Average slope (°)	Range of slope (°)	Dist. along transect (m)	Distance from nearest shore Min. (m)	Distance from nearest shore Max. (m)	Range of elevations (m)
1	250	87	2	30	32	27	20-42	0-87	0	40	2-32
2	250	135	4	32	42	25	0-52	0-135	0	80	4-42
3	255	107	1	32	32	31	25-40	0-107	0	107	1-32
4	310	67	2	26	26	23	11-33	0-67	0	67	2-26
5	317	127	2	40	40	20	2-40	10-127	10	127	2-40
6	330	127	4	33	33	22	1-42	--			
7	270	50	1	2	2	1	0-4	--			
8	60	107	1	13	14	11	2-32	70-107	60	65	13-14
9	68	167	5	38	38	14	0-32	30-167	30	95	9-38
10	80	147	1	45	45	22	0-46	10-110	20	110	1-35

Table EM720-7. Number of Ancient Murrelet burrows in 7mx7m plots along transects on west Limestone Island in 1983. Plots considered outside the colony are indicated by a dash. Numbers in bold print indicate plots within designated higher density area.

Transect	Plot 1	2	3	4	5	6	7	8	9
1	**2**	**4**	**1**	**1**	0				
2	**1**	0	0	0	0	1	0		
3	**1**	**1**	**0**	**1**	**2**	0			
4	0	**4**	**1**	0					
5	–	**2**	0	0	1	0	0		
6	–	–	–	–	–	–	–		
7	–	–	–						
8	–	–	–	–	0	0			
9	–	–	0	0	0	0	0	1	1
10	–	0	0	0	0	0	–	–	

Staging area: Ancient Murrelets were observed staging from just east of the Limestone Islands to off the north side of Reef Island (Fig. EM-2). This may have included birds from the Reef Island colony.

TOTAL NESTING POPULATIONS ON LIMESTONE ISLANDS

Pigeon Guillemot: 65 birds present

Ancient Murrelet: 1555 ± 310 pairs

Cassin's Auklet: 40 pairs

Rhinoceros Auklet: not verified; 2 suspected

Associated species:

Bald Eagle - 4

Peregrine Falcon

Northwestern Crow

Common Raven - 2; 1 nest suspected.

River Otter - 1 den on each island

Sitka Deer

Table EM720-8. Occupancy of Ancient Murrelet burrows along transects on west Limestone Island in 1983.

Date	Transect	Plot	Empty	1 cold egg	Adult + 2 eggs	Depredated burrow	Total occupied	Total known
5/05	1	1		1			1	1
5/05	1	2	1				0	1
5/05	1	3	2			2	2	4
5/05	1	4	3				0	3
5/05	2	1			1		1	1
5/05	2	4	1				0	1
5/05	2	6	1				0	1
5/05	2	7	1				0	1
5/05	3	1	1				0	1
5/05	3	2	1	1			1	2
5/05	3	3	1				0	1
5/05	3	4		2	1		3	3
5/05	3	5	3				0	3
5/05	4	2	1				0	1
5/05	4	3	1				0	1
6/05	4	4	1				0	1
6/05	5	2	2				0	2
6/05	5	3	1				0	1
6/05	5	5	1				0	1
6/05	5	7	1				0	1
6/05	8	6	1				0	1
6/05	9	3	1				0	1
7/05	9	4	2				0	2
7/05	9	8	1				0	1
7/05	9	9	1				0	1
6/05	10	2	2				0	2
7/05	10	6	1				0	1
		TOTALS	32	4	2	2	8	40

Table EM720-9. Depredated remains of Ancient Murrelets in 7mx7m plots along transects on west Limestone Island in 1983.

Transect	Plot	Feather pile	Single wing	Depredated egg	Bald Eagle pellet	Dug-up burrow
1	1	1	1			
1	4			1		
1	5				1	
2	1					1
2	6			1		
3	2	1				
3	4			1		
4	1	1				
4	2			2		
6	4	3				
6	6	1				
9	5	1				
10	8	1				
	TOTALS	9	1	5	1	1

EM-730 LOW ISLAND 103 B/13

Location: East of Louise Island, north of Reef Island.
52°54'30"N 131°32'W

Land status: Crown land.

Date of survey: 22 May 198' (main survey), and 21 June 1986, 1150-1245hrs (gull and oystercatcher count).

Colony access: Drop-off from boat.

Observers: 1983: D. Bertram, D. Powell, R. Reusch, Y. Turcotte.
1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Low Island has an area of 9.6ha, and rises to 66m elevation. It consists of a series of rocky knolls and ridges, covered mainly with thick salal under Sitka Spruce. Crabapple, salmonberry, twinberry, thimbleberry, and wild rose also occur. Around the edges of the knolls are open patches of grass and Maianthemum and small areas of bare ground occur in valleys at the perimeter. The rock at the northwest end is mostly bare rock with grass and forbs growing along cracks and in low areas on top: Achillea, Angelica, Sedum, Lupinus sp., Rosa, Fritillaria, Epilobium, Maianthemum and Mimulus. Old battery cases are strewn about from the light on the rock.

Nesting species:

Fork-tailed Storm-Petrel: We found petrels nesting around the perimeter of the island in open ground under roots, Maianthemum, and rocks, and a few under salal. Most burrows were within 10m of shore although 1 was located 40m inland.

Total burrows: 175 counted.

1983 Occupancy rate: We determined the contents of only 4 burrows, all of which were occupied. They contained 2 incubating adults, one adult without an egg, and one cold egg.

1983 Nesting population: 160 pairs.

Leach's Storm-Petrel: We found no evidence of nesting, but our survey occurred before their nesting season.

Black Oystercatcher: In 1983, we saw 5 birds on the island, and found 2 empty scrapes on the northwest tip of the island. In 1986, we found 1 empty nest of rock chips. There were 3 adults.

Glaucous-winged Gull: Gulls were nesting on the northwest tip of the island. In 1983, there were 7 empty nests and 63 adults present on 22 May. We counted the following nests in 1986:

Start	Empty	1E	2E	3E	Total
14	14	9	1	1	39

One empty nest contained a depredated egg. There was a feather pile of an adult gull.

Pigeon Guillemot: We counted 115 around the island in 1983. No nests were located. In 1986, there were 45 adults present. We found 1 nest with 2 eggs, and 1 empty nest with an old depredated egg in crevices. One recently depredated egg was also found.

Cassin's Auklet: Burrows were found in sporadic clumps around the perimeter of the island under grass tussocks, tree roots, and rocks within 10m of shore. One downy chick was pulled from a burrow.

Total burrows: 34 counted.

1983 Nesting population: 30 pairs.

Predation: There were signs of predation on Fork-tailed Storm Petrels (7 feather piles).

Associated species:

Bald Eagle - 16 seen soaring. Two nests:

1. Midway across island at south end, 15m high in 30m spruce. No adults present.

2. 50m from northwest tip, 20m high in 25m spruce 25m from shore. No activity around nest.

Northwestern Crow

Northern Sea Lion

River Otter

EM-740 SKEDANS ISLANDS 103 B/13

Location: Off the northeast corner of Louise Island.

52°57'24"N 131°34'W

Land status: Provincial Wildlife Management Area.

Date of survey: 8 and 10 May 1983 (main survey). 21 June 1986, 1310-1414hrs (gull count).

Colony access: Landings on the northwest point of the southern island, on the mid-eastern beach of the western island, and on the connecting beach on the eastern island. Drop-offs at other points.

Base camp: We did not camp here. Marginal camp sites may be present.

Observers: 1983: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte. 1986: M. Rodway, D. Garnier, D. Grinnell.

Census method: The north and east islands and the island adjacent to Skedans Point were total counted; the larger south and west islands were partially counted; and a 5m wide strip transect was run along the edge of the vegetation parallel to shore for 222m on the south side of the south island. Gulls nesting on the east rocks were total counted in 1986.

A problem was encountered in determining types of burrows found. Many were the typical size of Cassin's Auklet burrows but were being used by Storm-Petrels. Some of these petrel burrows narrowed at their ends. Decisions on which species was using a burrow were based on characteristic differences in fecal droppings, feathers, eggshells, and odour. Burrows that were used by

Cassin's Auklets often had more worn entrances with fecal streaking, but some Cassin's Auklets were found in unstreaked burrows.

Description: There are 5 islands in this group including the one lying just off Skedans Point (Fig. EM740-1). They have a total area of 37.9ha. We describe each island separately with a summary of nesting species and predation following the separate accounts.

ISLAND 1 (Most northern)

Description: The island has a total area of 3.1ha, 1.7ha of which are vegetated, and rises to a maximum elevation of 56m. The perimeter is rock with some small cliffs and crevices. The interior of this island is covered with thick salal growing as high as 2.5m under spruce and hemlock. The salal often extended right to the shore rock, but a considerable proportion of the perimeter had fringes of open grass, Maiamthemum or bare ground under spruce or hemlock trees.

Nesting Species: As was noted above, it was sometimes difficult to distinguish which species were utilizing burrows. On this island most of the petrel burrows were the expected size. It is possible however, that some of the burrows identified as Cassin's Auklet actually contained petrels.

Fork-tailed Storm-Petrels: A total of 57 petrel burrows were counted around this island. They were located in isolated patches of suitable habitat around the perimeter. The main concentration of 40 burrows was found along the northeast tip of the east point. Burrows were located under grass, in Maianthemum, and around spruce roots. They extended from the edge of the vegetation to a maximum of 8m inland. Contents of three burrows were determined and contained: a single adult, an incubating adult, and a cold egg.

Pigeon Guillemot: One cold Pigeon Guillemot egg was found in a burrow on the edge of the vegetation on the west end. No other nests were found.

Cassin's Auklet: A total of 33 Cassin's Auklet burrows were counted. Twenty-eight were located on a small headland on the northwest side, with the rest scattered on the north and south sides. Burrows occurred in the grass and in bare areas around spruce roots. Some were found concealed under the overhanging edges of the thick salal. All burrows were within 5m of the edge. One burrow contained an incubating adult and another held a cold egg.

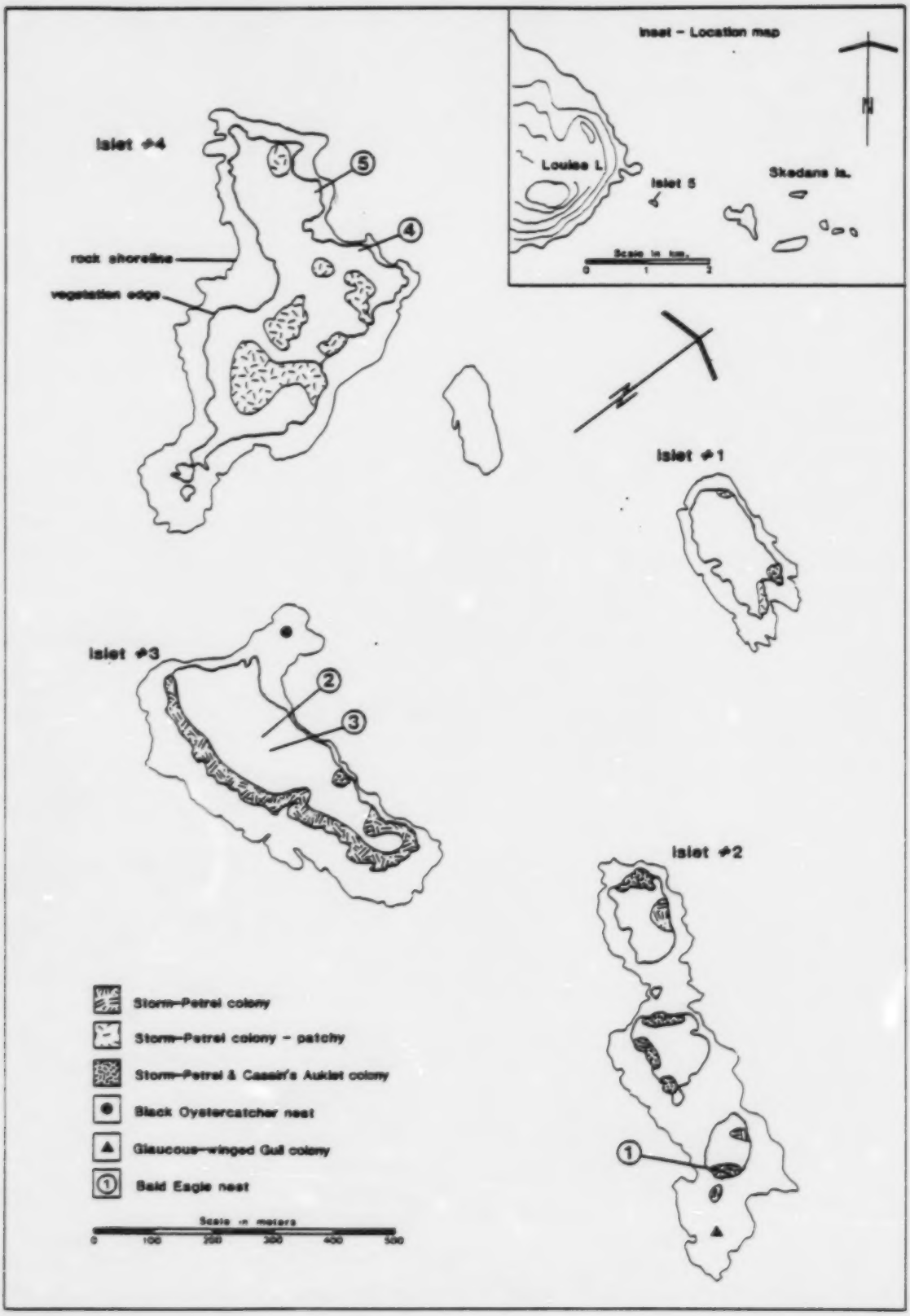

Figure EM740-1. Seabird colony areas on Skedans Islands in 1983.

ISLAND 2 (Eastern)

Description: This island is made up of three forested knobs connected by shore rock. Their total area is 8.9ha. The higher middle section rises to 47m elevation. The perimeter is rock with some small cliffs and crevices. On the east end is a large knob of rock, with small patches of grass.

The interior areas of the forested knobs were covered with salal under spruce. Perimeter habitat consisted of grass slopes, Maianthemum, bare areas under spruce, patches of salmonberry and elderberry, and on the eastern knob, some twisted crabapple. Between the eastern forested knob and the eastern rock was an isolated open area of Elymus and Angelica under spruce. Total vegetated area of this island is 2.9ha.

Nesting species:

Fork-tailed Storm-Petrel: A total of 303 petrel burrows were counted around this island. They were found in patches of suitable habitat around the perimeters of all three forested knobs. Burrows were located in grass, Maianthemum, bare areas under spruce, and under dense salmonberry and elderberry. The largest concentration of 130 burrows was found on the mid-north side of the western knob. Most burrows here were below a cliff under dense salmonberry, elderberry, and Maianthemum. Another group of 51 burrows was found in the isolated area of Elymus and Angelica at the eastern end.

Many petrel burrows on this island had large openings. In 7 burrows whose ends were reached, 6 contained incubating adults, and 1 held a cold egg.

Pelagic Cormorant: On 10 May 1983, 120 birds (mostly roosting immatures) were counted on the east end of the islet. Three nest starts were located. In 1986, 69 immatures were roosting on the south and east sides of the eastern rocks, but no cormorants were nesting.

Glaucous-winged Gull: Gulls were nesting on the outer east rocks. In 1983, they were just beginning to build nests; 1 empty nest and 2 nest starts were found. On 8 May, 70 adults were standing on territory. In 1986, we counted the following nests:

Start	Empty	1E	2E	3E	Total
6	13	1	13	16	49

Eggs were pipping in 1 nest of 2 eggs. We found 7 depredated eggs and 3 gull feather piles. There was a Bald Eagle feather beside one of the feather piles. Nests were made of grass and Sedum.

Pigeon Guillemot: Pigeon Guillemots were suspected to be nesting on the north side of the western knob, beneath and between large rocks at the edge of the vegetation. Six entrances with white fecal streaking were recorded. One empty nest cup was reached. One Guillemot eggshell was found on the eastern end of this western knob.

Cassin's Auklet: A total of 89 Cassin's Auklet burrows were counted around the perimeter of all three forested knobs. Burrows were located mainly on grassy slopes under spruce. The largest concentration of 40 burrows was found on the southeast corner of the eastern knob. The majority of the rest were located on the northwest end of the western knob. The contents of 3 burrows were determined: 1 contained an incubating adult, and 2 were empty.

ISLAND 3 (Southern)

Description: The southern island has a total area of 10.8ha, 5.7ha of which are vegetated. The topography and vegetation varies markedly from the north to the south side. On the north side, the island rises steeply and uniformly from 3m high rock bluffs along the shore to the maximum elevation on the island of 27m. On the south side of the island a tidal shelf extends far out from the shore and a high rocky beach exists well above the high tide line. In one or two areas the island is almost dissected by channels cutting through the shelf and into the forest.

Spruce is the dominant tree on the island but is smaller on the south side where the soil is thin and rocky. Hemlock mixes with the spruce on the north side where open patches of moss alternate with patches of sword and lady-fern (Athyrium filix-femina), elderberry, huckleberry, twinberry and salal. In runnels and gullies, Maianthemum, ferns, twinberry, huckleberry, elderberry and alder grow in dense profusion. Large areas of open mossy ground occur at the west end above where the sand spit joins the island, and there is an open grassy area near the east end. Salal is the dominant understory on the south side growing in continuous dense thickets to within 10m of the ridge crest. Patches of open ground occur around the bases of spruce trees and along the vegetation edge. Salal near shore is sporadic and short (less than 30cm high).

Nesting species:

Fork-tailed Storm-Petrels: Burrows were continuous along the southern shore from the west end around to the west side of the valley on the north-eastern end of the island. Separate areas of burrowing occurred in a mossy valley at the east end of the north side under Maianthemum, and in a 23m x 17m patch of grass with pockets of Maianthemum and salal on the north side of the island near the east end. Midway along the south side burrows extended 20-25m upslope and at the east end they occurred as far as 30m up the slope. The soil along most of the south side of the island was extemely compacted and dry, making digging next to impossible. Burrows occurred under trees, roots and logs, into short salal and in open patches amongst denser salal within 10-15m of shore. Some of the burrow entrances were small, typical storm-petrel sized burrows, but the majority were larger, typical Cassin's Auklet sized.

In a 5 meter strip along 222m of shoreline at the western end of the south side of the island 45 burrows were counted. The length of shoreline for this part of the colony was 740m. At an average width of 18m, this yielded 13,320m^2 of nesting habitat, giving an estimate of 540 burrows for this area.

Twelve of 24 burrows counted in the pocket on the east end were identified as storm-petrel burrows, giving an overall estimate of 552 petrel burrows for the island.

We determined the contents of 7 burrows: 2 with single adults, 3 with adults incubating eggs, and 2 with cold eggs. Four other burrows explored contained Fork-tailed Storm-Petrel feathers.

Cassin's Auklets: We found 4 burrows at the east end of the island with heavy fecal streaking at the burrow entrance, and estimated 12 of 24 burrows counted in the grassy area near the east end on the north side were Cassin's Auklet burrows. We estimated a total of 20 burrows on this island. An incubating adult was found in one burrow under a log.

ISLAND 4 (largest western island)

Description: Much of the area on this 14.6ha island has little slope, being flat across much of the interior. Rising from the flats is a series of rocky ridges that run in a general east-west direction. These ridges are larger and more predominant toward the southern half of the island, with the northern half more uniformly level. At the northern end the flats are again disrupted with a number of rocky knobs and ridges close to the shore. Most of the shore is rock except for two stretches of high tide beach in the bay on the mid southwest side. The east running ridges extend out to the east shore creating a number of rocky promontories with valleys between them. The ridges on this island rise to a maximum elevation of 20m.

There is 8.2ha of vegetated area on the island. The forest of the island is composed of small spruce, mostly about 0.2 to 0.5m dbh with some larger spruce as well as some alders and larger willows in the interior. The interior flat areas of the island have an understory of salal, huckleberry, twinberry, and small willows, with patches of sword fern and moss. Within 20 to 30m of the eastern shore in the flat areas the salal becomes shorter and open areas of moss and grass become predominant. On the western side the salal is thicker right to the shore. On the rocky ridges there is mainly short salal with some mossy patches and grassy fringes.

Nesting species:

Fork-tailed Storm-Petrel: The total number of petrel burrows on this island was estimated to be 250. Burrowing was very scattered, occurring in isolated patches. Burrows were located primarily along the raised rock ridges in open mossy areas around roots and under rock jumbles. Some burrows were found under short salal. A few burrows were found in the flat valleys between the ridges. A total of 117 burrows were actually counted in various isolated patches. The rest were estimated.

A number of these burrows had large, Cassin's Auklet size entrances. These were all assumed to be petrel burrows as no signs of Cassin's Auklets were found on the island. Only evidence of nesting by Fork-tailed Petrels was

found: 5 birds were heard calling from burrows, 1 adult incubating an egg was pulled, and one old petrel eggshell and one eggshell membrane were found in two separate burrows.

Some larger sized burrows did not appear used this year. These were not counted in the above estimate. Others had a short growth of moss over what appeared to be an old entrance platform, but the inside of the burrow was well worn. From one of these types of burrows a Fork-tailed Storm-Petrel was heard calling.

ISLAND 5

Description: Island 5 is the small vegetated island situated just offshore of Skedans village site. The vegetation consists mostly of a thick salal understory in an open spruce forest, with some grasses around the fringes. In the interior of the island some twinberry and crabapple were growing.

Nesting Species:

Fork-tailed Storm-Petrel: Five burrows, suspected to be petrel burrows, judging from the small size and smell, were found along the north side of the island along the top edges of the steep rock bluffs under dense overhanging salal.

Cassin's Auklet: Four burrows suspected to be Cassin's Auklet burrows, based on the size and amount of fecal streaking, were found in the same area as the petrel burrows noted above. None of the burrows could be explored to their full extent to determine contents. Most tunnels were worn and went into rock crevices.

SUMMARY OF NESTING SPECIES ON THE SKEDANS ISLANDS

Fork-tailed Storm-Petrel: We found petrels nesting on all islands, primarily around the perimeters within 20m of shore under grass, Maianthemum, tree roots, and rock. Some burrows were found under salal, salmonberry, and elderberry. Of the 19 occupied burrows found, 12 held incubating adults, 3 held single adults, and 4 contained cold eggs. No signs of Leach's Storm-Petrels were found but our survey occurred before their nesting season. If they do nest, their numbers are likely small, as almost all burrows explored held Fork-tailed Storm-Petrels.

Total burrows:

North Island - 57

East Island - 303

South Island - 552 (Density = 405 burrows/ha; Area = 1.37ha)

West Island - 250 (117 counted)

Skedans Pt. I. - 5

Total 1167

1983 Occupancy rate: 19 of 20 known - 95%

1983 Nesting population: 1110 pairs

Pelagic Cormorant: On 10 May 1983, three nest starts were located on the east end of the eastern islet. No cormorants were nesting in 1986.

Black Oystercatcher: In 1983 we saw 10 adults around the islands. One nest with 1 egg, and 2 empty scrapes were located on the rocky spit at the northwest corner of the south island.

Glaucous-winged Gull: Gulls were nesting on the outer east rocks of the eastern island. In 1986, we counted the following nests:

Start	Empty	1E	2E	3E	Total
6	13	1	13	16	49

Pigeon Guillemot: A maximum of 136 were counted around the islands on 8 May 1983, congregated around the north and south side of the large west island and off the east end rocks. One cold egg was found in a burrow on the edge of the vegetation on the west end of the northern island, and 6 nest sites under rocks were located on the east island. In 1986, there were 78 birds present. We found 1 nest with 1 egg and 1 eggshell (could not tell if hatched or broken).

Cassin's Auklet: We found Cassin's auklets nesting sporadically around the perimeter of all islands except the large western island (#4) where all Cassin's Auklet sized burrows appeared to be occupied by storm-petrels. Burrows were located under grass, tree roots, and the edges of salal. Of the 5 occupied burrows found, 3 held incubating adults, 1 contained an adult with a small chick, and 1 held a cold egg.

Total burrows:

North Island - 33

East Island - 89

South Island - 20

West Island - 0

Skedans Pt. I. - 4

Total 146

1983 Occupancy rate: 5 of 7 known - 71%

1983 Nesting population: 103 pairs

Predation: We noted signs of predation on Fork-tailed Storm Petrels (14 wings, 16 feather piles, and 2 eggshells), Cassin's Auklet (2 eggshells), Glaucous-winged Gulls (2 adults), and Pelagic Cormorants (1 adult). Bald Eagles and river otters were the principal predators on the islands. The cormorant and gull remains were found in and around eagle nests and some otter scats contained feathers in an area where 1 Cassin's Auklet and 2 petrel burrows had been partially dug up.

Associated species:

Bald Eagles - Six Bald Eagle nests were located within the Skedans Islands group (Fig. EM740-1). Sightings were made on 10 May.

1. Eastern end of East Islet, on top of a 15m high spruce tree. Two chicks were in the nest, the adults were circling and calling above. Depredated remains of 1 Pelagic Cormorant, 1 Glaucous-winged Gull, and herring were found in the nest.

2. Mid-north side of South Islet, 35m high in a 50m high spruce tree, near the ridge crest of the island at an altitude of 25m. The stick nest was approximately 2m high. One adult landed in the nest.

3. Mid-north side of the South Islet, 25m high in a 35m spruce tree at the top of the island (30m elevation). This is a dilapidated nest close to nest 2.

4. Just east of the 2nd bay at the northwest end of the west island, 25m high in a 28m spruce tree 5m from shore. The nest was lined with moss. It was empty with no signs of occupancy this year.

5. Between 2 bays at the northwest corner of the west island, 18m high in a 25m tree in a spruce tree 5m from shore. Two downy eaglets (15cm long) were in the nest. One sat up and listened to adult's call, the other was lying down. There was half a fish in the nest, 2 fish remains below the nest. The nest was lined with moss and some grass. Two adult Bald Eagles were present: one was perched in the nest tree above the nest, and one in another tree was calling.

6. Small islet just offshore of village site, 15m high in an 18m high spruce 20m from shore. Two adult Bald Eagles seen near nest.

A maximum of 15 Bald Eagles were seen around the Skedans Islands on 10 May.

Northwestern Crow - 1 nest found

Hair Seal - 28 seals were hauled out on island 1 on 8 May at 1400hrs.

Northern Sealions - 161 sealions were hauled out on the rocks and in the water on the rocks at the east end of the east islet on 8 May.

River Otter - Scats and trails were seen on each island. Two dens were located on the west islet. One under a large boulder at the south end of the bay on the east side. The other den was located at the north end of the bay on the east side.

EM-790 CUMSHEWA ISLAND 103 G/4

Location: At the mouth of Cumshewa Inlet. 53°01'48"N 131°36'W

Land status: Crown land.

Date of visit: 21 June 1986, 1458-1530hrs.

Colony access: Landing on spit at west end.

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: Total count.

Description: Bare rock with small patches of grass, Rumex, Achillea and Potentilla.

Nesting species:

Black Oystercatcher: 1 empty scrape of rock chips and shell. 2 adults.

Glaucous-winged Gull: We counted the following nests:

Start	Empty	1E	2E	3E	Total
3	8	5	8	13	37

Two empty nests contained a depredated egg each. Nests were made of grass, Rumex and Cochlearia.

Pigeon Guillemot: There were 62 adults on the rock and in the water. We found 1 nest with 1 egg and 1 nest with 2 eggs.

Associated species:

Pelagic Cormorant - 21 immature

Glaucous-winged Gull - 52 immature

Hair Seal - 30 on beach at west end

ISLANDS SURVEYED WITH NO HISTORY OF NESTING BY SEABIRDS

During the course of our surveys a number of islands were explored that had no evidence of nesting by seabirds. Any of these islands that had previous documentation of nesting have been included in the the main list of colonies. Those with no historical confirmation of nesting have been listed here ordered geographically from south to north. We observed seabirds (eg. Pigeon Guillemots) in the vicinity of some of these islands, but no evidence of nesting was obtained.

GERMANIA ROCK 103 B/3

Location: South of High Island on the northeast side of Kunghit Island.

52°07'09"N 131°0'10"W

Date of visit: 5 June 1985 (1445hrs).

Observers: M. Rodway, M. Lemon.

Census method: Counted from boat only.

Description: Rock.

Sightings:

Pelagic Cormorant: 4 immatures

Glaucous-winged Gull: In 1985, 27 adults were standing on the rock. In 1986, we were working in the area from 5 June to 18 June and saw no evidence of nesting.

ELLEN ISLAND 103 B/3

Location: In Houston Stewart Channel, north of Rose Harbour.

52°09'20"N 131°05'30"W

Land status: Crown Land: part of proposed South Moresby National Park.

Date of visit: 8 June 1986, 1215-1330 hrs.

Colony access: Drop-off from boat.

Observers: M. Lemon, D. Grinnell, H. Hay, N. Holmes.

Census method: Exploration.

Description: Ellen is a low, 17.6ha island forested with redcedar, hemlock and spruce with an understory of mostly moss and bare ground. Salal and alder occur in patches around the shore, and salal and huckleberry are sporadic in the interior. Some windfalls have occurred along the north shore.

Sightings:

Three old petrel-sized burrows were seen on the southeast corner of the island. There was no sign of use by petrels.

A total of 80 old Rhinoceros Auklet sized burrows were scattered around the perimeter under roots and into banks near shore. The entrances to most of these burrows were mossy and a number contained limpet and crab shells. The entrances to 7 burrows were worn, but there were no droppings or other signs of seabird use. One old Rhinoceros Auklet feather pile was found on the north side.

Pigeon Guillemot - 4 birds were on the rocks and water on the southwest corner of the island.

River Otter - den, many runways and scats.

Sitka Deer - lots of sign.

ROSS ISLAND 103 B/3

Location: At the mouth of Rose Inlet in Houston Stewart Channel.

52°09'42"N 131°07'07"W

Date of visit: 8 June 1986, 1430-1530 hrs.

Observers: M. Lemon, D. Powell, D. Grinnell, H. Hay, N. Holmes.

Census method: Exploration.

Description: Ross Island is 21ha in size and rises to a maximum elevation of 64m near the south end. Much of the island is flattish with an even coastline. At low tides it is connected to Moresby Island. Towards the south end there are raised knolls along a more dissected coastline. It is forested with redcedar, spruce and hemlock, with alder and crabapple growing around the perimeter. Most of the understory is moss or bare ground, with salal occurring in patches, especially on the rocky knolls along the shore. On the southwest corner, storm waves have damaged the vegetation as far as 10m inland.

Some large, old stumps and cut logs were found in the interior. There has been an archeological camp on the northeast side of the island.

Sightings:

Pigeon Guillemot - 26 birds were in the water off the east end.

Bald Eagle - 1 nest 20m high in 30m tree near the southwest bay.

Racoon - scats

River Otter - dens, runways and scats.

Sitka Deer

BURNABY ISLAND 103 B/6

Location: South side of Juan Perez Sound. 52°15'N 131°15'30"W

Date of visit: 5 May 1985 (1500-1945hrs).

Observers: M. Lemon, M. Rodway.

Census method: Exploration. The only area explored was on the east side south of Scudder Point on the slopes approximately 1km north and 1km south of the large bay due north of Howay Island.

Description: This area has steep slopes covered mostly with salal under spruce, hemlock and redcedar. There are some open mossy slopes and knolls. Seepage areas occur in flatter areas between the steeper slopes.

Sightings: We made records of birds present while boating past Burnaby Island and through Dolomite Narrows at various times during the season. The following is a list of seabirds and associated species observed. See also Appendix V.

Black Oystercatcher

Glaucous-winged Gull - 600 in bay south of Alder Island on 16 April. Probably feeding on herring spawn.

Pigeon Guillemot - 24 through Dolomite Narrows on 17 April

Marbled Murrelet - 4 through Dolomite Narrows on 3 May

Bald Eagle - 14 along west shore on 23 April

Common Raven

MONUMENT ROCK 103 B/6

Location: Off the north end of Huxley Island. 52°28'15"N 131°21'21"W

Date of visit: 19 June 1986 (2114hrs).

Observers: M. Rodway, D. Garnier, D. Grinnell.

Census method: We only boated around the rock.

Description: Mostly bare, vertical columns, with a grassy section on top.

Sightings:

One Black Oystercatcher was on the low rocks, otherwise we saw no seabirds.

SIVART ISLAND 103 B/12

Location: North of Haswell Bay on the west side of Juan Perez Sound

52°32'15"N 131°35'20"W

Date of visit: 19 June 1986.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Exploration.

Description: This 8.4ha island has mostly open, mossy ground under a redcedar, hemlock and spruce forest, with patches of huckleberry, salal and regenerating hemlock.

Sightings: No sign of seabirds.

River Otter - dens and runs

DE LA BECHE ISLAND 103 B/12

Location: At the mouth of De la Beche Inlet at the west side of Juan Perez Sound. 52°32'20"N 131°37'30"W

Date of visit: 19 June 1986.

Observers: D. Powell, H. Hay, N. Holmes.

Census method: Only surveyed from boat.

Description: De la Beche Island has an area of 27ha. The southwest side is very low, but the northeast and southeast points are higher and steeper. It is mostly covered with salal under dense redcedar forest, with open areas on the points.

Sightings:

Black Oystercatcher - 2 on the northwest point.

River Otter - adult and young in northeast bay.

FARADAY ISLAND 103 B/11,12

Including the small islet at the northeast end.

Location: South of Lyell Island. 52°36'30"N 131°29'W

Date of visit: 16 May 1984.

Observers: D. Bertram, M. Biro, E. Lofroth, C. Rodway.

Census method: Exploration. The entire perimeter and as far as 100m inland was searched. The middle of the island was not explored.

Description: Most of the perimeter of Faraday Island is low-lying with little slope except along the west end where there are steep almost impassable cliffs. The island has a total area of 308ha. Most of the island is covered with thick salal under a young (50-150 year old) forest of redcedar, spruce and hemlock. Wet seepage areas with stands of Red Alder occur along much of the north and south sides and extend as far as 100m inland. There are a few open patches under redcedar in the interior along the north side and on the steeper slopes at the northeast corner. The small northeast islet is covered with dense salal. There were many signs of logging along the south side.

Predation: We found a pair of Pigeon Guillemot wings and a pile of plucked

feathers.

Sightings:

Pelagic Cormorant - 2 immatures

Black Oystercatcher - 5

Glaucous-winged Gull - 4

Pigeon Guillemots - 40 were counted around the island and may nest along the rocky shore later in the season.

Marbled Murrelet - 5

Bald Eagle - 2 nests:

1. On the mid-north side, 20m high in 45m spruce 20m from shore with 2 adults perched nearby.

2. On the northeast islet, 15m high in 18m cedar 10m from shore with an adult sitting in the nest.

- A total of 14 (1 immature) were seen around the island.

Northwestern Crow - 10

River otter

Sitka Deer

SKAGA ISLAND 103 B/11

Location: Off the east side of Lyell Island. 52°41'32"N 131°23'20"W

Date of visit: 9 May 1982 (1530-1700hrs).

Observers: M. Lemon, M. Rodway.

Description: This 4.5ha island has bare, basaltic sides with grass and forbs on top under a few spruce trees. Patches of salal and twinberry occur in the center.

Census method: Exploration.

We found no present sign of nesting seabirds. Three old Cassin's Auklet sized burrows were found.

Sightings:

Pelagic Cormorant - 1 in breeding plumage.

Black Oystercatcher - 4 (May nest later in the season).

Bald Eagle - 2 ad. - 1 empty nest.

Northwestern Crow - 4 - 1 empty nest.

KUNGA ISLAND 103 B/13

Location: South side of Laskeek Bay, east of Tanu Island. 52°46'N 131°34'W

Date of survey: 15 May 1983 (1100-1730hrs).

Observers: M. Lemon, M. Rodway, D. Bertram, D. Powell, R. Reusch, Y. Turcotte.

Census method: Exploration.

Description: Kunga is a steep island rising to a maximum elevation of 450m. It has an area of 450ha. Most slopes are open with little ground vegetation under a forest of spruce, hemlock, redcedar, spruce, and alder. There are many large trees of all these species. The island offers extensive habitat for burrow nesting seabirds. No evidence of burrowing was found.

Sightings:

Pigeon Guillemot - There were 6 on the water off the west side.

Bald Eagle - 4 adults, 1 subadult

Black Oystercatcher - 1

Glaucous-winged Gull -3

Marbled Murrelet -6

Common Raven

Hair Seal - 1

River Otter

FLOWER POT ISLAND 103 B/13

Location: At the mouth of Logan Inlet, north of Tanu Island.

52°47'05"N 131°39'W

Date of survey: 13 May 1983 (1717-1815hrs).

Observers: M. Rodway, D. Bertram, Y. Turcotte.

Census method: Exploration.

Description: This is a steep-sided island, rising to a maximum elevation of 78m, with an area of 2.1ha. Thick salal covers most of the edges and top under a forest of spruce, redcedar, hemlock, and alder. On the south side, below the cliffs, is a steep, open slope of moss and sword fern. There are a few open mossy areas on the top amongst the salal. We found no evidence of burrowing.

Sightings:

Pigeon Guillemot - There were 2 Pigeon Guillemots on the water along the south side.

Bald Eagle - 1 adult, 2 immatures

Black Oystercatcher - 4

Northwestern Crow - 6

Hair Seal - 15

Sitka Deer

HASWELL ISLAND 103 B/13

Location: At the mouth of Selwyn Inlet off Dass Point. 52°51'44"N 131°41'10"W

Date of survey: 13 May 1983 (1200-1350hrs).

Observers: M. Lemon, M. Rodway, D. Bertram, R. Reusch, Y. Turcotte.

Census method: Exploration.

Description: Haswell is a low, undulating island, with an open mossy forest of spruce, hemlock, and redcedar. It has an area of 13.3ha, and rises to a maximum elevation of 59m. Most trees are small (0.2 to 0.3m dbh) with some larger ones in the interior. No nesting seabirds were found.

Predation: 2 Fork-tailed Storm-Petrel feather piles were found.

Sightings:

Bald Eagle

Black Oystercatcher

Northwestern Crow

River Otter

Racoon - 2 seen

TOTAL BREEDING POPULATIONS ON THE EAST COAST OF MORESBY ISLAND

The East Coast Moresby region supports over half a million breeding seabirds, including 238,000 Ancient Murrelets, 144,000 Cassin's Auklets and 115,000 storm-petrels (Table EM-1). The most important concentrations occur in Skincuttle Inlet, on Rankine Islands and around Ramsay Island. Table EM-1 includes data for a few small colonies of Black Oystercatchers, Glaucous-winged Gulls and Pigeon Guillemots not surveyed since 1977. Population estimates from 1977 (Campbell and Garrioch 1979; British Columbia Nest Record Scheme) for those colonies have been included to present total estimates for the region. Historical data interpreted in Rodway et al. (in prep) has been used to list extinct or unused colonies.

The following codes have been used on Table EM-1 to indicate the type of population estimates presented. A more detailed definition of these codes can be found in Rodway et al. (in prep).

S: breeding suspected but not directly observed

x: breeding confirmed but population not estimated

e: population estimated without systematic sampling or total counts

t: population estimated from systematic sampling along transects

26: a number without a code indicates a total count

E: extinct

(): number of birds in breeding plumage on or near the colony

Acronyms for species names follow Campbell and Harcombe (1985) (see Appendix VI). "SP-T" means total storm-petrels.

Table EM-1. Current summary of seabird breeding populations on the east coast of Moresby Island. Estimates are of breeding pairs for all species except Pigeon Guillemots and Tufted Puffins. To include Pigeon Guillemots and Tufted Puffins, total populations are given as individual birds. Data codes and sources are explained on previous page.

	SP-T	FTSP	LSPE	PECO	BLOY	GWGU	PIGU	ANMU	CAAU	RHAU	TUPU	TOTAL BIRDS	SURVEY YEAR(S)
EM-010 Kunghit I.				22	7	29e	S(155)	8800e	50eS	2500e	x(323)	23294	1986
EM-020 Marshall I.					1S		17 (27)					29	1986
EM-030 Gull Islet					2	1eS	1x(8)					14	1986
EM-040 Rainy Islands	100eS				3	26	6x(20)					278	1986
EM-050 High Island							S(8)	0		10eS		28	1985
EM-060 Haydon Rock					1	1						4	1986
EM-070 Charles I.	100e	100e					1x(24)		0	130S		484	1985,1986
EM-080 Annette I.							6x(16)		0	20S		56	1985,1986
EM-090 Garcin Rocks						102	3 (6)					210	1986
EM-100 Langtry Island	12300t	x	x		3		3x(7)		0			24813	1985
EM-110 Samuel Rock					1	5	13eS(13)					25	1977
EM-120 Rankine Is.	14300t	2000t	12300t		5	43	S(12)	25000t	26000t			132708	1984-1986
EM-130 Marion Rock					1	1						4	1986
EM-140 Nest Islets					4	0	(25)					33	1986
EM-150 Inner Low Rock					1							2	1986
EM-160 Joyce Rocks					1	197	S(9)					405	1986
EM-170 Sea Pigeon I.							S(5)	E				5	1985
EM-180 Boulder I.							(0)	E				0	1985
EM-190 Green Rock					3	3	5x(21)					33	1986
EM-200 "Jedway" Rks.					2		(1)					5	1977
EM-210 Bush Rock					0		(1)					1	1986
EM-220 Bolkus Is.	230eS				4	1	S(41)	9800t	980t	20eS		22271	1985,1986
EM-230 Swan Islands					4	1	S(4)					14	1986
EM-240 "Pelican" Rk.					2	1						6	1986
EM-250 Slug Islet					2	48	1x(5)					105	1986
EM-260 Rock Islet	17000t	4700t	12300t		4	1	2x(6)	0	5100t			44216	1985,1986
EM-270 Skincuttle I.	4300t	x	x		1			2200t	1000t			15002	1985,1986
EM-280 George I.	E	0	0					11600t	5900t			35000	1985
EM-290 Jeffrey I.							(0)	1000t	2700t			7400	1985
EM-300 East Copper I.	40eS	20eS	20eS		2		S(30)	4400t	10900t			30714	1985
EM-310 Howay Island	10eS	10eS		0	2S	10e	S(6)	300e	250eS			1150	1985,1986
EM-320 "Island Bay" Gp.					1S	0	(2)					4	1986
EM-330 "Kat" Rocks					9	6	9x(28)					56	1986
EM-340 Centre Islet							10e(10)					10	1986
EM-350 Wanderer I.					1S		S(35)					37	1986
EM-360 Sels Islet		0			5		S(40)					50	1986
EM-370 Park Island					1S		S(27)					29	1986
EM-380 Koga Island							S(36)					36	1986
EM-390 Nakons It.					1		(0)					2	1985
EM-400 Alder I.	60S				3	1S	S(2)	14400t	3200t			35330	1985

Table EM-1 cont'd

	SP-T	FTSP	LSPE	PECO	BLOY	GWGU	PIGU	ANMU	CAAU	RHAU	TUPU	TOTAL BIRDS	SURVEY YEAR(S)
EM-410 Huxley I.					2		(29)					33	1977
EM-420 Arichika I.		0	0		1S		S(7)	E	E			9	1985
EM-430 Marco Rock					5	18	8x(30)					76	1986
EM-440 Hutton I.							10e(11)					11	1977
EM-450 Hoskins Its.		E			1		9x(92)					94	1986
EM-460 Tatsung Rock					4	11	(0)					30	1986
EM-470 Ramsay Island				14eS	2	16e	S(29)	18200t	12900t			62293	1984
EM-480 Ramsay Rocks					2S	5						14	1986
EM-490 Bischof Is.	50eS				0		S(24)	E				124	1985
EM-500 Hotspring I.	900e	x	S		1		15e(24)	6e	10eS			1858	1984,1986
EM-510 House I.					0		S(10)	2600t	40eS			5290	1984
EM-520 Kloo Rock					1	0	(0)					2	1984
EM-530 Murchison I.				0	2	27e	S(28)	20e	50eS			226	1984,1986
EM-540 Agglomerate I.	5500t	x			2	2	2x(12)	2200t	200eS			15820	1985,1986
EM-550 Kawas Is.	700e	x			3	11	4e(5)		200e			1833	1984-1986
EM-560 Tar Islands	330e	x	x	0	10e	32e	x(46)	0	120eS			1030	1985,1986
EM-570 Tuft I.						(1)	(1)		0		E	1	1982
EM-580 Lyell Island				1	3		S(4)	10700t				21412	1982,1986
EM-590 Topping Is.					1S		15+e(15)					17	1977
EM-600 Gil Islet					1S		1S(1)					3	1977
EM-610 Dog Island							6+e(37)					37	1977
EM-620 Kul Rocks					1S	0	S(1)					3	1986
EM-630 Kelo Rocks					2	2	x(13+)					21	1971
EM-640 Titul I.							S(114)		170			454	1983
EM-650 Lost Islands	80	80	x		3	75	S(31)		210			767	1983,85,86
EM-660 Helmet I.				0			S(19)					19	1983
EM-670 Proctor Rks.					1		(3)					5	1977
EM-680 Kingsway Rock					1	43	3x(72)					160	1986
EM-690 Reef Island	140e	x		11		7	S(338)	5000t	1700e			14054	1983,85,86
EM-700 South Low I.					1S	0	S(18)					20	1986
EM-710 Vertical Point				0			(1)					1	1986
EM-720 Limestone Is.							S(65)	1500t	40	2S		3149	1983
EM-730 Low Island	160	x		0	2	38	2x(115)		30			577	1983,1986
EM-740 Skedans Is.	1100e	1100e		0	3	48	7x(136)	E	100			2640	1983,1986
EM-750 Mabbs It.							27 (60)					60	1977
EM-760 Hedden I.					2		(174)					178	1977
EM-770 Oliver It.					1		(2)					4	1977
EM-780 Kingui I.		0			1		S(4)					6	1977
EM-790 Cumshewa I.					1	37	2x(62)					138	1986
TOTAL NESTING PAIRS	57400	8010+	24620+	48	137	851		118626	71830	2682			
TOTAL BREEDING BIRDS	114800	16020+	49240+	96	274	1702	2263	237652	143660	5364	323	506134	
NUMBER OF SITES	19	15+	7+	4	57	33	67	17	23	6	1	78	

METHODOLOGICAL CONSIDERATIONS AND RECOMMENDATIONS

The goal of the inventory program was to establish baseline estimates of breeding seabird populations using replicable survey techniques. Total counts conducted at the appropriate time are readily compared. Partial counts are adequate to detect substantial changes in nesting distribution and population on small colonies. Changes in population estimates for large colonies are more difficult to interpret. The level of precision of estimates derived from systematic sampling along transects depends on the precision of three components which enter into their calculation: colony area, burrow density and burrow occupancy rate. Each component has its own sources of error.

In the methods presented in this report, there is no measure of error for colony area calculations, and its level of precision is unknown. Distance, slope and elevation measurements taken along transects help delineate nesting areas, but precise identification of colony boundaries depends on thorough exploration, careful observations and detailed and explicit note-taking. Sources of error arise whenever observations or field notes are not comprehensive enough to allow unequivocal definitions of colony limits. Training of observers in what evidence to look for, and how to record it unambiguously, is an essential element of an inventory program and directly influences the quality of data obtained. Having an experienced corps of surveyors from year to year maintained a consistent standard for defining colony limits.

The standard error of the average burrow density has been calculated for each site (Tables EM-2, EM-3, EM-4). The level of precision and accuracy depends on burrow distribution, sampling intensity and appropriate selection of quadrat size and spacing. Compromises were made between the level of precision desired and the time required to obtain that level. Average densities for small colonies often have large standard errors because they were sampled with few plots. Observer bias in indentifying burrows may create an unmeasured subjective error especially for Ancient Murrelet burrows, some of which require careful examination to distinguish from holes in the ground. Consistent criteria, experienced observers and mutual consultation minimized discrepancies. Studies are required to evaluate the importance of this bias.

It is difficult to obtain reliable occupancy data when attempting to collect population data for a number of species at a number of colonies in the same season. The nesting phenology of species varies, and surveys conducted in April and May to coincide with the nesting of Ancient Murrelets and Cassin's Auklets are too early for storm-petrels. Though we were able to calculate proportions of Fork-tailed Storm-Petrels at some colonies, overall occupancy rates for storm-petrels at colonies on the east coast of Moresby Island are lacking.

Burrow ocupancy rates were not determined on small alcid colonies. On most large alcid colonies, occupancy was determined in a replicable manner though sampling schemes varied. Where occupancy was sampled at only one or two locations within a colony, no standard error could be calculated, making future comparisons more difficult to interpret.

Digging alcid burrows to determine occupancy is a laborious and time-consuming task. Often half or more of the attempts are unsuccessful. As a result, it was generally not feasible to determine the occupancy of burrows within all quadrats, and occupancy was determined in only some of the quadrats. Selection of quadrats was not systematic or random, but typically resulted from the delegation of an amount of work to be accomplished in one day. We recommend not attempting to explore burrows in all quadrats unless more time is spent than on the present surveys. On storm-petrel colonies in other regions of the coast, we selected quadrats by randomly choosing one plot along each transect (see Rodway et al. in prep (d)). A similar method would be appropriate for alcids as long as enough burrows were located within chosen plots to obtain an adequate sample. There is an advantage to sampling burrow occupancy separately from burrow density. Effort spent exploring burrows was more productive when determining occupancy was the sole objective of the activity. Excavating burrows within plots along transects was generally less efficient due to the continual switching of activities from recording and measuring to digging. Research on the variation in occupancy rates within and between colonies, and over time, is required to assess and improve sampling methodology (see Gaston and Jones 1984; Gaston and Collins 1988).

Table EM-2. Sampling efforts and population parameters for transected colonies of storm-petrels on the east coast of Moresby Island.

Colony code	Colony name	Colony area (ha)	Density (burrows/ha ± S.E.)	No. of sample plots	Area sampled (%)	Burrow occupancy (% ± S.E.)	Sampling effort[1] (%)	Population estimate (pairs ± S.E.)
EM-100	Langtry I.	1.3	10413 ± 3464	8	0.6	M	0	12319 ± 4098
EM-120	Rankine Is.							
	-west	3.9	666 ± 200	9	0.6	M	0	2363 ± 710
	-east	2.3	5730 ± 1380	12	0.5	M*	0.19	11993 ± 2888
EM-260	Rock It.**	1.5	5386 ± 1273	7	0.4	M*	0.16	7414 ± 1753
EM-270	Skincuttle I.	4.8	975 ± 429	9	0.9	M*	0.19	4259 ± 1874
EM-540	Agglomerate I.	9.5	640 ± 140	20	0.5	M	0.03	5533 ± 1210

1 Number of burrows with known contents/total burrows.

M Median occupancy rate was used because sample was too small.

* A sample of burrows was explored but no occupancy rate was calculated because survey was too early in the breeding season.

** Main islet only.

Table EM-3. Sampling efforts and population parameters for transected colonies of Ancient Murrelets on the east coast of Moresby Island.

Colony code	Colony name	Colony area (ha)	Density (burrows/ha ± S.E.)	No. of sample plots	Area sampled (%)	Burrow occupancy (% ± S.E.)	Sampling effort[1] (%)	Population estimate (pairs ± S.E.)
EM-120	Rankine Is.							
	-west	38.3	1042 ± 105	89	0.6	65.6 ± 7.7	0.16	26180 ± 4041
EM-220	Bolkus Is.*	16.5	636 ± 88	33	1.0	83.3 ± 9.4	0.17	8727 ± 1554
EM-270	Skincuttle I.	6.1	627 ± 174	14	1.1	57.1 ± 21.0	0.37	2182 ± 982
EM-280	George I.	27.1	558 ± 74	57	1.0	76.8 ± 5.6	0.37	11614 ± 1751
EM-290	Jeffrey I.	4.0	408 ± 204	7	0.9	M	0.18	1028 ± 514
EM-300	East Copper I.	17.8	388 ± 83	31	0.9	63.2 ± 10.5	0.28	4365 ± 1170
EM-400	Alder I.	47.4	467 ± 48	83	0.9	65**	0.10	14388 ± 1479
EM-470	Ramsay I.	138.7	203 ± 21	229	0.8	64.5 ± 7.3	0.11	18161 ± 2783
EM-510	House I.	20.0	294 ± 44	36	0.9	45	0.53	2646 ± 396
EM-540	Agglomerate I.	9.5	360 ± 76	20	0.5	M	0	2155 ± 455
EM-580	Lyell I.	125.8	163 ± 28	221	0.4	52.0 ± 3.0	0.37	10663 ± 1930
EM-690	Reef I.	39.5	199 ± 30	72	1.8	63	0.75	4942 ± 747
EM-720	Limestone Is.							
	-east	14.9	160 ± 30	98	1.7	61.0 ± 5.9	3.37	1449 ± 305
	-west	4.4	120 ± 30	42	4.7	20.0 ± 8.4	7.55	105 ± 50

1 Number of burrows with known contents/total burrows.
M Median occupancy rate was used because sample was too small.
* Transected area only.
** Occupancy rates without standard errors were determined at a single location.

Table EM-4. Sampling efforts and population parameters for transected colonies of Cassin's Auklets on the east coast of Moresby Island.

Colony code	Colony name	Colony area (ha)	Density (burrows/ha ± S.E.)	No. of sample plots	Area sampled (%)	Burrow occupancy (% ± S.E.)	Sampling effort[1] (%)	Population estimate (pairs ± S.E.)
EM-120	Rankine Is.							
	-west	11.3	3103 ± 493	33	0.7	62.1 ± 7.4	0.08	21775 ± 4306
	-east	2.1	3050 ± 1340	12	0.5	*	0	3978 ± 1799
EM-260	Rock It.**	1.2	2880 ± 1250	5	0.4	M	0	2594 ± 1127
EM-270	Skincuttle I.	2.0	653 ± 253	5	1.1	M	0	980 ± 380
EM-280	George I.	7.0	1130 ± 290	11	0.8	75.0 ± 7.2	0.10	5933 ± 1619
EM-290	Jeffrey I.	2.5	1497 ± 1192	3	0.6	71.4 ± 8.2	0.19	2673 ± 2136
EM-300	East Copper I.	9.3	1404 ± 312	17	0.9	83.3 ± 7.2	0.23	10876 ± 2585
EM-400	Alder I.	4.0	952 ± 290	12	1.5	80***	0.38	3174 ± 928
EM-470	Ramsay I.	22.7	880 ± 140	46	1.0	71.4 ± 11.0	0.12	12887 ± 2771

1 Number of burrows with known contents/total burrows.
M Median occupancy rate was used because sample was too small.
* Rate from west island used.
** Main islet only.
*** Occupancy rates without standard errors were determined at a single location.

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APPENDIX I. Median occupancy rates for burrow-nesting seabirds in British Columbia (percent).

At a number of colonies of burrow-nesting seabirds that were surveyed, no occupancy rate was determined, either because the colony was too small, the survey was done too early in the breeding season, or it was too difficult and time consuming to determine the contents of an adequate sample of burrows. To estimate nesting populations at these colonies, we calculated a median occupancy rate for each species from all colonies in British Columbia where occupancy rates had been determined.

Colony	Species				Date
	Storm-Petrel	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet	
Langara Island		26*			May-Jun 1981
Frederick Island		54	65		May-Jun 1981
Hippa Island	82	78	83		May-Jun 1983
Helgesen Island		63			May 1986
Anthony Island			74	64	May-Jun 1985
Rankine Islands		66	62		May 1984
Bolkus Islands		83			May 1985
Skincuttle Island		57			May 1985
George Island		77	75		May 1985
Jeffrey Island			71		May 1985
East Copper Island		63	83		May 1985
Alder Island		65	80		Apr 1985
Ramsay Island		65	71		Apr-May 1984
House Island		45			May 1984
Lyell Island		52			Apr-May 1982
Reef Island		63			May-Jun 1985
Limestone Is. (E)		61			Apr-May 1983
(W)		20*			Apr-May 1983
Skedans Island	95		71		May 1983
Moore Islands				77	Jun 1988
Whitmore Island				77	Jun 1988
Byers Islands			85	94	Jun 1988
Storm Islands	90			77	Jul 1987
Reid Islands	91				2 Aug 1987
Tree Islets	90				Jul 1986
Pine Island				87**	Jul 1985, 1986
Buckle Group					
- Bright Island	95				3 Aug 1987
- Herbert Island	92				3 Aug 1987

APPENDIX I. (continued)

Colony	Species				Date	
	Storm-Petrel	Ancient Murrelet	Cassin's Auklet	Rhinoceros Auklet		
Triangle Island				66**	Jul	1984, 1985
Sartine Island			91		Jul	1987
Beresford Island	81		90		Jul	1987
Gillam Island	98				Jul	1988
Solander Island	97				Jul	1988
Thomas Island	85				Jul	1988
Cleland Island	83				Jul	1988
Seabird Rocks	100				Jul	1988
Median	91	63	75	77		

* Rates for Ancient Murrelets from Langara Island and west Limestone Island were not included in the calculation of the median occupancy rate since these are thought to be disturbed and declining colonies. (Though this did not change the median rate.)

** Rates for Rhinoceros Auklets from Pine Island and Triangle Island are averaged over two years of data.

Data from this report, Rodway et al. 1983, Rodway et al. in prep. (a,b,c,d,e and f).

APPENDIX II. Permanent seabird monitoring plots established on the east coast of Moresby Island.

As part of the Permanent Seabird Monitoring Program for the British Columbia coast, Permanent Plots for Ancient Murrelets and Cassin's Auklets were established on the following islands. A detailed description of each plot and the number of burrows found within each plot is housed in the Permanent Seabird Monitoring Program file at the Canadian Wildlife Service office in Delta, B.C.

RAMSAY ISLAND

In 1984, 12 Ancient Murrelet plots (20mx20m), and 8 plots (15mx15m) and 1 plot 20mx24m for Cassin's Auklet were established on Ramsay Island. The Cassin's Auklet plots were all located at the shoreline. The Ancient Murrelet plots were measured from 8 bearing points located at the shoreline. Bearing points were marked with 4" x 6" engraved aluminum tags nailed over red plastic backings onto conspicuous tree trunks. Three blank aluminum tags were also nailed around marked trees. All plots were marked with similar engraved and blank aluminum tags nailed on the tree closest to the lower left corner of the plot (when facing the interior of the island). The tags for the Cassin's Auklet plots had white plastic backings. The corners of all the plots were marked with flat aluminum stakes, 1 1/2" wide and 2' tall. The stakes were colour coded with red, yellow, green and blue florescent tape, and ordered in a counter clockwise direction around the plot, beginning, when facing the interior of the island, with red at the lower left corner.

RANKINE ISLAND

Permanent Plots were established for Ancient Murrelets and Cassin's Auklets on Rankine Island in 1984. We located 8 plots (10mx10m) for Cassin's Auklets around the perimeter of the island, and 8 plots (15mx15m) for Ancient Murrelets placed at various distances from shore. These plots are located by bearing points fixed at the shore. Plot markings are similar to those used on Ramsay Island.

GEORGE ISLAND

On George Island in 1985 we established 8 plots (20mx20m) for Ancient Murrelets, located at various distances from bearing points on shore. Plot markings were similar to those on Ramsay Island.

EAST COPPER ISLAND

Six plots 15mx15m for Cassin's Auklets were established on East Copper Island in 1985. Plots were located around the perimeter of the island. Plot markings were similar to those described for Ramsay Island.

APPENDIX III. Banding and Morphometrics.

During the course of population surveys we banded and made morphological measurements of a number of birds and eggs. Almost all adults banded or measured were breeding birds found in burrows. All Cassin's Auklet chicks were also found in burrows. Ancient Murrelet chicks banded and measured on Rankine Islands were caught on their way to the sea. Appendix table III-a lists the numbers of birds banded on specific islands. More detailed information on banded birds is filed at the Canadian Wildlife Service office in Delta. Appendix tables III-b, III-c and III-d list measurements of birds and eggs made during our surveys on the east coast of Moresby Island. Eggs were being incubated unless otherwise noted.

Appendix III-a. Seabirds banded at colonies on the east coast of Moresby Island.

Island	Ancient Murrelet		Cassin's Auklet		Date
	breeding adults	young of year	breeding adults	young of year	
Ramsay Island	11	0	4	3	May-June 1984
House Island	9	0			May-June 1984
Rankine Island	5	151	18	6	June 1984

Appendix III-b. Measurements of Ancient Murrelet adults and chicks made at colonies on the east coast of Moresby Island.

adults					chicks			
date	weight (g)	tarsus (mm)	culmen (mm)	wing (mm)	date	weight (g)	tarsus (mm)	culmen (mm)
Ramsay Island - 1984					Rankine Islands (W) - 1984			
6 May	203	26.0	13.4	146	30 May	25.5	24.3	7.2
6 May	231	27.8	14.6	143	30 May	26.0	25.0	6.8
6 May	202	27.5	14.6	134	31 May	25.0	25.8	6.6
6 May	193	27.3	13.4	141	31 May	24.5	27.2	6.2
6 May	206	26.8	14.5	144	31 May	26.5	24.8	6.8
9 May	225	28.2	13.7	138	31 May	28.0	25.4	6.2
9 May	214	27.2	13.4	143	31 May	24.5	26.2	7.3
15 May	206	25.6	13.1	144	1 Jun	27.5	26.8	6.4
15 May	196	28.2	13.5	141	1 Jun	27.5	25.5	6.8
11 May	198	28.6	-	139	1 Jun	25.5	24.5	6.7
13 May	220	26.9	13.6	145	1 Jun	24.5	25.8	6.9
20 May	225	28.6	15.3	146	1 Jun	29.0	25.5	6.9
27 May	221	27.2	13.4	143	1 Jun	26.5	25.5	7.1
27 May	-	27.2	14.0	135	1 Jun	24.0	24.6	7.1
27 May	220	26.9	12.8	133	1 Jun	24.0	25.8	7.1
House Island - 1984					1 Jun	24.0	26.0	7.2
19 May	224	28.7	13.1	140	1 Jun	26.0	24.8	7.0
19 May	211	27.3	12.7	135	1 Jun	24.0	25.1	7.2
19 May	204	28.9	13.7	137	1 Jun	28.5	25.9	6.9
19 May	210	27.1	13.6	141	1 Jun	26.0	27.4	7.1
19 May	210	28.6	14.4	144	1 Jun	27.5	24.8	7.0
19 May	215	26.8	14.4	142	1 Jun	25.5	26.5	6.7
19 May	234	28.1	14.2	141	1 Jun	24.5	25.8	6.5
19 May	211	26.7	14.1	141	1 Jun	26.5	24.9	7.1
19 May	206	28.2	13.6	141	1 Jun	24.0	24.3	6.3
Rankine Islands (W) - 1984					1 Jun	25.5	24.8	7.4
30 May	178	26.9	13.3	144	1 Jun	25.0	25.0	6.6
30 May	193	27.4	14.2	140	1 Jun	24.0	24.8	6.5
31 May	225	27.2	12.7	142	1 Jun	30.0	26.8	6.9
2 Jun	196	27.8	13.6	139	1 Jun	23.5	24.2	7.0
					1 Jun	26.0	24.7	7.3
mean	210	27.5	13.7	141	1 Jun	26.5	24.4	7.2
s.d.	13	.8	.6	4	1 Jun	26.5	25.7	6.7
N	27	28	27	28	1 Jun	25.5	24.6	6.8
					1 Jun	28.5	25.0	6.7
					1 Jun	26.5	27.0	7.0
					1 Jun	23.5	24.8	7.1
					mean	25.8	25.4	6.9
					s.d.	1.6	.9	.3
					N	37	37	37

Appendix III-c. Measurements of Ancient Murrelet eggs made at colonies on the east coast of Moresby Island.

date	clutch number	weight (g)	length (mm)	width (mm)
Ramsay Island - 1984				
3 May	1-cold	43.0	58.9	36.4
3 May	2	48.0	61.0	38.3
3 May	2	47.0	60.5	37.9
3 May	3	43.0	58.3	37.6
3 May	3	44.5	58.5	37.9
6 May	4	44.0	59.0	37.9
6 May	4	45.0	60.6	38.1
6 May	5	47.0	63.3	38.6
6 May	5	45.0	61.2	38.2
6 May	6	42.5	58.8	36.7
6 May	6	42.5	59.6	36.5
6 May	7	42.5	62.0	36.0
6 May	7	42.5	59.4	36.4
6 May	8	47.5	58.1	38.9
6 May	8	48.0	58.7	38.8
7 May	9-cold	39.5	60.0	36.2
7 May	10-cold	37.5	57.8	34.3
8 May	11	42.0	57.8	36.7
8 May	11	42.0	57.3	36.9
9 May	12	39.0	56.8	36.0
9 May	12	36.0	56.0	34.5
9 May	13	44.0	58.5	38.4
9 May	13	42.5	58.4	37.5
9 May	14-cold	43.5	58.1	37.0
11 May	15-cold	40.0	56.6	35.4
11 May	16	46.0	60.7	38.1
11 May	16	45.0	59.5	37.7
13 May	17	46.0	62.1	37.3
13 May	17	49.0	62.8	38.0
15 May	18	43.0	59.0	37.8
15 May	18	43.0	57.7	37.8
15 May	19	38.0	61.4	36.6
15 May	19	41.0	58.5	38.3
15 May	20	43.0	60.2	36.5
15 May	20	47.0	61.8	37.4
15 May	21-cold	45.5	59.2	37.3
15 May	22	43.0	58.3	37.5
15 May	22	42.0	58.5	37.3
15 May	23	43.0	60.1	38.2
15 May	23	46.0	59.9	39.0
16 May	24	42.0	59.3	37.2
16 May	24	41.0	58.8	37.3
20 May	25	44.0	58.0	38.4
20 May	25	43.5	59.4	37.7
20 May	25	41.0	59.2	37.1
20 May	25	45.5	59.8	37.4
25 May	26-cold	50.5	61.5	38.8
Rankine Islands (W) - 1984				
30 May	1	39.0	55.7	37.1
30 May	1	38.5	58.0	36.7
31 May	2	40.5	61.3	37.9
31 May	2	38.0	57.6	37.5
31 May	3-cold	40.0	56.0	36.4
31 May	3-cold	38.0	53.4	36.0
31 May	4	41.0	57.2	37.1
31 May	4	40.0	57.1	37.0
31 May	5-cold	43.0	58.2	36.7
31 May	6-cold	46.5	58.2	38.3
2 June	7	37.0	58.9	35.9
2 June	7	39.0	60.8	35.4
2 June	8-cold	48.0	60.4	38.6
2 June	8-cold	47.0	60.4	38.5
2 June	9-cold	45.0	59.1	37.5
4 June	10-cold	41.5	59.8	36.0
4 June	10-cold	40.5	61.0	35.5
4 June	11	37.0	61.2	37.0
4 June	11	37.5	59.0	36.7
4 June	12	35.0	59.6	34.5
4 June	12	34.5	56.5	35.5
4 June	13-cold	46.0	60.5	39.1
4 June	13-cold	45.0	59.6	39.0
Alder Island - 1985				
23 Apr	1	47.0	59.1	38.6
23 Apr	1	45.0	57.5	38.3
23 Apr	2	48.0	61.1	38.7
23 Apr	2	47.0	60.7	38.1
23 Apr	3	46.0	59.0	37.4
23 Apr	3	47.0	59.0	37.5
23 Apr	4	52.0	60.7	39.3
23 Apr	4	54.0	61.8	39.6
23 Apr	5	45.0	58.0	37.9
23 Apr	5	46.0	58.0	38.0
23 Apr	6	40.0	58.8	36.2
23 Apr	6	39.0	57.2	36.2
23 Apr	7	48.0	60.8	38.2
23 Apr	7	46.0	60.0	38.0
23 Apr	8-cold	47.0	60.0	37.5
23 Apr	9	41.0	60.8	35.1
23 Apr	9	47.0	62.8	37.0
23 Apr	10	45.0	57.1	39.2
23 Apr	10	44.0	58.0	38.2
23 Apr	11	50.0	60.5	39.0
23 Apr	11	51.0	60.2	39.4
23 Apr	12	42.0	60.2	36.2
23 Apr	12	42.0	60.2	35.8

Appendix III-c cont'd

date	clutch number	weight (g)	length (mm)	width (mm)
	Ramsay Island cont'd			
27 May	27	39.0	60.1	36.5
27 May	27	37.0	57.3	36.8
27 May	28+chick	36.5	57.9	37.0
27 May	29	39.0	59.8	38.0
27 May	29	39.5	60.0	37.7
	House Island - 1984			
19 May	1-cold	46.0	62.1	37.2
19 May	2	38.0	57.3	35.8
19 May	2	39.0	59.4	36.1
19 May	3	40.0	56.8	37.8
19 May	3	41.0	55.2	38.8
19 May	4	41.0	56.1	37.5
19 May	4	43.0	59.0	37.9
19 May	5	37.0	57.6	35.7
19 May	5	37.0	58.5	36.1
19 May	6	41.0	63.1	35.4
19 May	6	39.0	59.8	35.2
19 May	7-cold	30.0	57.8	33.9
19 May	8-cold	45.0	61.3	36.5
19 May	8-cold	44.0	60.2	36.3
19 May	9	38.0	58.0	36.3
19 May	9	40.0	59.6	36.3
19 May	10-cold	43.5	58.2	36.3
19 May	11	41.0	54.8	38.1
19 May	11	41.0	55.7	37.3
19 May	12	39.0	pipping	
19 May	12	40.5	pipping	
19 May	13	40.0	56.8	36.9
19 May	13	42.0	58.7	37.4
19 May	14	40.0	59.5	37.2
19 May	14	39.0	57.2	36.6
	East Copper Island - 1985			
28 Apr	1	40.0	59.3	36.2
28 Apr	1	40.0	59.5	35.9
6 May	2-cold	42.0	61.2	35.8
6 May	2-cold	41.0	60.9	35.2
6 May	3-cold	42.0	60.0	35.7
11 May	4-cold	41.0	58.6	36.1

	length (mm)	width (mm)
mean	59.2	37.2
s.d.	1.9	1.2
N	165	165

date	clutch number	weight (g)	length (mm)	width (mm)
	George Island -1985			
29 Apr	1-cold	43.0	57.0	37.6
29 Apr	1-cold	44.0	58.3	37.6
29 Apr	2-cold	39.0	59.6	34.4
29 Apr	3	50.0	62.1	38.7
29 Apr	3	49.0	62.3	38.5
29 Apr	4	49.0	60.9	39.5
29 Apr	5	40.0	54.9	37.0
29 Apr	5	39.5	54.3	36.4
29 Apr	6	41.0	60.0	36.2
29 Apr	6	43.0	59.5	37.3
29 Apr	7	43.0	59.6	37.1
29 Apr	7	43.5	61.3	36.6
29 Apr	8	49.0	61.9	38.6
29 Apr	8	49.0	61.5	38.6
29 Apr	9	45.0	60.9	38.0
29 Apr	9	45.0	59.3	38.1
29 Apr	10	41.0	57.0	37.0
29 Apr	10	41.0	58.2	36.7
29 Apr	11	43.0	59.1	37.7
29 Apr	11	45.0	60.3	38.1
29 Apr	12	45.0	60.4	37.4
29 Apr	12	44.0	61.8	37.0
29 Apr	13	44.0	61.1	36.6
29 Apr	13	43.0	60.5	36.5
29 Apr	14	44.0	60.1	37.6
29 Apr	14	49.0	63.2	38.6
29 Apr	15	49.0	63.3	38.5
29 Apr	15	48.0	61.4	38.4
29 Apr	16	42.0	57.9	37.4
29 Apr	16	41.0	57.8	37.0
29 Apr	17-cold	47.0	61.4	37.3
29 Apr	18	45.0	59.0	38.0
29 Apr	18	44.0	58.9	37.8
30 Apr	19	45.0	59.8	37.6
30 Apr	19	47.0	59.9	38.5
30 Apr	20-cold	46.0	59.1	37.4
30 Apr	20	36.0	54.4	34.8
30 Apr	20	40.0	57.0	35.8

Appendix III-d. Measurements of Cassin's Auklet adults, chicks and eggs made at colonies on the east coast of Moresby Island.

CAAU adults

date	weight (g)	tarsus (mm)	culmen (mm)	wing (mm)
Ramsay Island - 1984				
6 May	190	25.1	19.1	127
6 May	211	25.8	20.6	130
6 May	201	24.9	19.3	127
15 May	177	29.0	16.0	127
15 May	173	29.0	17.8	129
28 May	197	27.2	18.4	136
28 May	187	26.4	18.6	131
Rankine Islands (W) - 1984				
30 May	201	26.1	19.6	128
30 May	184	26.6	20.5	127
30 May	193	24.9	18.7	127
30 May	167	26.9	19.5	133
30 May	161	24.3	18.1	130
31 May	168	24.5	22.2	128
31 May	181	25.0	18.8	130
31 May	203	26.9	19.5	130
31 May	176	25.0	19.4	130
31 May	189	25.5	19.3	129
31 May	194	26.9	19.2	134
31 May	183	26.0	20.3	129
31 May	184	25.4	18.0	129
1 Jun	184	25.2	20.0	127
1 Jun	148	26.2	18.5	132
1 Jun	166	26.6	19.8	132
1 Jun	156	25.3	17.8	131
1 Jun	175	27.1	20.5	133
mean	182	26.1	19.2	130
s.d.	15.5	1.2	1.2	2.5
N	25	25	25	25

chicks

date	weight (g)	tarsus (mm)	culmen (mm)	wing (mm)
Ramsay Island - 1984				
6 May	26.0	-	9.5	18
15May	15.5	18.0	7.2	31
15May	51.0	21.0	10.5	52
15May	21.5	19.0	10.0	33
28May	40.0	19.4	9.4	46
Rankine Islands (W) - 1984				
30 May	108	22.6	15.0	60

CAAU eggs

date	weight (g)	length (mm)	width (mm)
Ramsay Island - 1984			
3 May	26.0	44.9	33.2
4 May	24.5	48.3	33.6
4 May	26.5	48.8	34.6
4 May	29.0	51.0	32.5
4 May	28.0	46.2	34.3
5 May	28.5	46.5	34.7
5 May	32.5	49.0	36.0
5 May	30.5	48.9	35.6
5 May	24.5	46.4	33.2
6 May	25.0	45.9	33.0
6 May	24.0	48.5	32.9
15 May	25.0	46.7	30.6
28 May	24.8	45.7	33.1
Rankine Islands (W)- 1984			
30 May	25.0	46.3	32.7
30 May	36.5	51.6	35.9
30 May	18.5	49.6	28.0
31 May	30.0	49.7	33.8
31 May	25.5	45.6	33.6
4 June	26.0	42.6	32.6
4 June	30.0	46.4	33.9
Alder Island - 1985			
23 Apr	27.0	46.8	34.6
23 Apr	31.0	48.6	35.5
23 Apr	25.5	45.2	32.7
23 Apr	25.0	46.5	33.6
23 Apr	27.5	47.5	35.3
23 Apr	29.5	49.6	33.6
23 Apr	26.0	45.2	34.1
23 Apr	28.5	48.9	33.7
23 Apr	30.5	50.8	34.3
23 Apr	28.5	46.5	33.4
23 Apr	24.0	45.4	33.2
23 Apr	26.5	47.6	33.6
George Island - 1985			
30 Apr	31.5	47.4	34.3
30 Apr	26.0	48.0	33.8
East Copper Island - 1985			
28 Apr	28.0	45.7	34.3
28 Apr	27.0	47.3	32.5
28 Apr	29.0	49.3	33.3
28 Apr	29.5	48.1	35.0
6 May	27.0	49.0	34.7
6 May	23.5	45.4	33.3
mean		47.4	33.7
s.d.		1.9	1.4
N		40	40

APPENDIX IV. Experiments with other methods.

Experimental Trapping of Ancient Murrelets at Burrow Entrances to Determine Burrow Occupancy

One of the problems in estimating populations of burrow nesting seabirds is the difficulty in determining whether the burrows are occupied or empty. Burrows usually extend well beyond the reach of a field workers' arm. Digging additional entrances to burrows to determine if they are occupied or empty is a time consuming and often impossible task, particularly when they are located around roots or under trees or rocks.

Method

In 1984, we experimented with a trapping technique on Ramsay Island to see if we could develop a better method of determining burrow occupancy. Two experimental plots, one 20mx20m and the other 20mx40m, each with 20 burrows, were set up in the Ancient Murrelet colony near transect 29. Sock-shaped nets were placed at the entrance to each burrow to catch birds entering the burrows on their incubation shift. Since Ancient Murrelets shift incubation duty on average every 3 nights, three nights were spent at each plot to ensure that most pairs had gone through a shift.

Results

In the 3 nights on the first plot birds were caught in only 3 burrows, and at the second plot only one bird was caught. Other birds were seen and heard to approach and inspect the burrow entrance but not enter the trap.

Conclusion

Observer disturbance was a major problem with this method of trapping birds. Often on our approach, the bird would either escape from the net, or having not yet entered the trap, fly away from the slope.

Walking through the plot disturbed other birds that were on the slope or coming in and had not yet approached their burrows. Some other trap, such as an inconspicuous spring release trap that would require only periodic inspection would probably be more successful.

The three day incubation shift inevitably makes any type of trapping a time consuming method of determining occupancy of Ancient Murrelet burrows. With other seabird species trapping is more effective when adults are feeding chicks, but it is impossible with Ancient Murrelets because of the precocial departure of the chicks.

Experimental trapping of Cassin's Auklets at burrow entrances to determine burrow occupancy

On Rankine Island we were testing trapping techniques for Cassin's Auklets. We attempted to trap the birds as they left their burrows during feeding or incubation shifts. The experiment was performed over the nights of 30 and 31 May 1984.

Method

Standing toothpicks were placed in the entrances of 19 burrows on 30 May. That evening we checked the burrows every 30 minutes to see if the toothpicks had been knocked over, indicating that a bird had entered the burrow. If this occurred we placed previously constructed sock nets at the burrow entrances. These consisted of a piece of net sewn into a sock shape, with a hoop of wire fed around the mouth and holding the sock open. They were fastened so the outgoing bird could only come out into the sock if it left the burrow. On 31 May, we improved 7 of the sock nets by placing a one-way flap trap at the burrow entrance. This trap consisted of a 10x15cm aluminum flap hinged from an inverted horseshoe of wire that was staked into the ground, with the net sock attached to the outside of the flap. This would allow the bird to leave the burrow, but it would then be trapped in the net and unable to return to its burrow.

If a bird was found in the trap, it was quickly removed to an adjacent area, so as not to disturb other birds entering experimental burrows, where it was banded, weighed, measurements of culmen, tarsus, and wing length taken, and brood patch checked to determine if it was a breeding bird. Once this was done the bird was returned to its burrow and the trap was dismantled. We felt that releasing the bird back in its burrow would be less disorienting and less likely to cause desertion than releasing it outside.

Results

On the night of 30 May, 14 of the 19 burrows had birds enter them and sock nets erected at the entrances. One Cassin's Auklet was caught coming out of its burrow and one other was caught trying to get into its burrow after another one had already entered and the sock net was in place. We also caught 1 Leach's Storm-Petrel emerging from one of the burrows. On eight occasions birds emerged from their burrows into the sock net and then merely turned around and reentered the burrow when they found they could not escape. To prevent this we erected the one way flaps at seven of the burrows that had been entered on the night of 30 May. During the night of 31 May, 3 Cassin's Auklets were caught in these flap-traps, 2 from the same burrow. Two other Cassin's Auklets and one Leach's Storm-Petrel (the mate to the one caught 30 May) were caught in the original sock nets that were still in place from the night before.

Conclusions

Trapping birds emerging from their burrows, with the methods used was not a reliable means of determining occupancy. In two consecutive nights of trapping, birds were caught from only 50% of the burrows that birds had entered the first night. In order to use trapping as a method of determining occupancy, less conspicuous methods must be developed.

APPENDIX V. Birds and mammals sighted during seabird nesting surveys 1982-1986.

The following table is a summary of bird and mammal sightings made while conducting inventories of nesting seabirds. Dates of sightings correspond to the survey dates listed in the island accounts. Most of these sightings have been recorded with more detailed information on sight record cards filed at the Royal British Columbia Museum. Sightings of non-nesting seabird species and other bird and mammal species relevant to the ecology of nesting seabirds are described in more detail in the individual island accounts under Associated species. Islands on the table without reference numbers are listed in the section on "Islands Surveyed With No History of Nesting by Seabirds".

Key to symbols used on table.

x: recorded
9: maximum sighted
i: immature
11i5: means 11 immature,5 adults
n: nests
2n14: means 2 nests, 14 birds
m: male
f: female
S: suspected from scats
r: remains

Abbreviations used for bird and mammal species follow Campbell and Harcombe 1985. See Appendix VI for species names.

Appendix V. Birds and mammals sighted during seabird nesting surveys 1982-1986.

	PALO	COLO	HOGR	RNGR	SOSH	DCCO	GBHE	BRAN	CAGO	GWTE	MALL	NOSL	GRSC	HADU	SUSC	WWSC	BUFF	COME	RBME
EM-010 Kunghit I.	18	3i														12		2	
EM-040 Rainy Islands														1m					
EM-120 Rankine Is.																800			
EM-140 Nest Islets														1m					
EM-160 Joyce Rocks														3					
EM-170 Sea Pigeon I.																		1	
EM-220 Bolkus Is.		6	1	4							2		3	13	50	700		1	2
EM-230 Swan Islands						1i								4				1	
EM-250 Slug Islet														16m					
EM-260 Rock Islet														30m					
EM-270 Skincuttle I.						3i								3m3f					
EM-280 George I.		1		1				2						1m1f				2	
EM-300 East Copper I.	12	1		1	10000	1						2		1m1f		24			
Burnaby Island		3	4	55			3				18			8	1500	1000	65	6	24
EM-340 Centre Islet		1																	
EM-350 Wanderer I				2r															
EM-400 Alder I.						5i								255		30			3
EM-420 Arichika I.		1		1															
EM-430 Marco Rock														57m					
EM-470 Ramsay Island	7	2				1	1		140		53			3		65		5	2
EM-480 Ramsay Rocks														24m2f					
EM-490 Bischof Is.														48m				1	
EM-500 Hotspring I.		2		1		1i	2			1	1m1f			11m4f			12m13	1m3f	1m3f
EM-510 House I.				2						6				9m9f		1	7		
EM-530 Murchison I.							2											2	
Faraday I.																9			
EM-550 Kawas Is.														9					
EM-580 Lyell Island	45	2	1	3	2		1	180		15	26		6	31	12	2	2	7	12
Kunga Island														32					
EM-640 Titul I.														2					
Flower Pot I.														4					
EM-690 Reef Island		1																	
EM-700 South Low I.		1												2					
Em-710 Vertical Point		1		1						15	3	12	35	16m2f		30		3m1f	
EM-740 Skedans Is.		1i												2m2f		24			

Appendix V. cont'd

	BAEA	SSHA	RTHA	PEFA	BLGR	LGPL	GRYE	WATA	BLTU	COSN	PAJA	HEGU	THGU	BLKI	SAGU	COMU	MAMU	SNOW	NSWO
EM-010 Kunghit I.	14n		1	9	x												80		
EM-020 Marshall I.	1n																		
EM-040 Rainy Islands	1n																		
EM-050 High Island					x												.		
EM-070 Charles I.	1																		
EM-080 Annette I.	1n																		
Ross Island	1n																		
EM-100 Langtry Island	2n																		
EM-120 Rankine Is.	9n			1												12		r	
EM-140 Nest Islets	2																		
EM-170 Sea Pigeon I.	1																		
EM-180 Boulder I.	1n																		
EM-220 Bolkus Is.	3n15																16		
EM-230 Swan Islands	1																		
EM-250 Slug Islet	1n																		
EM-260 Rock Islet	2n																		
EM-270 Skincuttle I.	1n13											1i1	15	30i30					
EM-280 George I.	3n	1															1	r	
EM-290 Jeffrey I.	1n																		
EM-300 East Copper I.	1n59			1				1				120*	10	300	3				x
EM-310 Howay Island	1			3															
Burnaby Island	14				x			1									4		
EM-350 Wanderer I	1																		
EM-380 Koga Island	1																		
EM-390 Nakons It.	1																		
EM-400 Alder I.	3n						1		20										1
EM-410 Huxley I.	1				x														
EM-420 Arichika I.	1n			1	x														
EM-470 Ramsay Island	14n		1					1									6		
EM-490 Bischof Is.	5n				x														
EM-500 Hotspring I.	1i4	1				1	2		3	1									1
EM-510 House I.	2n		1														2		
EM-520 Kloo Rock	1																		
EM-530 Murchison I.				1	1														
Faraday I.	2n14	1															5		
EM-540 Agglomerate I.					1														
EM-550 Kawas Is.	2n				1n														
EM-560 Tar Islands	2n																		
Skaga Island	1n																		
EM-570 Tuft I.	1n																		
EM-580 Lyell Island	8n30		1	4	1n			3	14		3	66				2	292		2
EM-590 Topping Is.																	245		
EM-620 Kul Rocks	1																		
Kunga Island	1i4				1												6		
EM-640 Titul I.	1			1															
Flower Pot I.	2i1							1											
EM-650 Lost Islands	2n			1								20i							
EM-660 Helmet I.	1n																		
Haswell I.	1																		
EM-690 Reef Island	5n10			4															
EM-700 South Low I.	2n14											1*							
EM-710 Vertical Point	3			1	x			x									6		x
EM-720 Limestone Is.	5			1															x
EM-730 Low Island	2n16																		
EM-740 Skedans Is.	6n15											8i*							

* HEGU/THGU

Appendix V. cont'd

	BEKI	RUHU	RBSA	HAWO	NOFL	WEFL	TRSW	BASW	MACR	CORA	CBCH	BUSH	RBNU	BRCR	WIWR	GCKI	RCKI	TOSO	SWTH	HETH	VATH
EM-010 Kunghit I.	1	x	4n	1n		x			x	x	x		x	x	x		x		x	x	x
EM-020 Marshall I.									6												
EM-040 Rainy Islands		x							x												
EM-050 High Island			1n			x			x	x	x				x	x					x
EM-070 Charles I.									3												
EM-080 Annette I.									1n												
Ross Island																					x
EM-100 Langtry Island		x							12												
EM-120 Rankine Is.		x		x		x			2n15	2			x	x	1n	x			x	1n	x
EM-170 Sea Pigeon I.		x							x						x					x	
EM-180 Boulder I.		x		x																	
EM-220 Bolkus Is.		x	x	x		x			19n	x	x				x	x					x
EM-230 Swan Islands															x						
EM-250 Slug Islet		x							x												
EM-260 Rock Islet					1n				1n												
EM-270 Skincuttle I.	x	x							4n	x					x					x	
EM-280 George I.	2			x					2n	3	x				x					x	
EM-290 Jeffrey I.	1					x			1n4											x	
EM-300 East Copper I.	2	x		1n		x			7n	1n	x				x				x	x	
EM-310 Howay Island		x							x						x						
Burnaby Island	1			x						x	x				x					x	
EM-330 "Kat" Rocks									2n												
EM-340 Centre Islet									x												
EM-350 Wanderer I	1									x					x					x	x
EM-360 Sela Islet		x							2n												
EM-370 Park Island										4											
EM-390 Nakons It.					1				5n		x										
EM-400 Alder I.	2			1					13n	1n	x			x	x	x				x	x
EM-410 Huxley I.																					x
EM-420 Arichika I.									x		x			x	x						
EM-430 Marco Rock									1n												
EM-450 Hoskins Its		x							20												
Sivart Island											x				x					x	
EM-470 Ramsay Island	1		1	2		x			x	1n	x		x		x			1	x	x	x
EM-490 Bischof Is.	1			x						x					x					x	
EM-500 Hotspring I.		x				x	x		10	2	x	10			x					x	x
EM-510 House I.					1				19	1					x						
EM-530 Murchison I.	x			x						x					x						x
Faraday I.									10		x					x				x	
EM-540 Agglomerate I.									x						x						
EM-550 Kawas Is.		x							12						x						
EM-560 Tar Islands		x							44						x						
Skaga Island									1n4												
EM-570 Tuft I.									4												
EM-580 Lyell Island	1	x		x	1	x	6	2	16	x	x		x	x	x	x				x	x
EM-620 Kul Rocks									15												
Kunga Island		x	x			x				x					x					x	x
EM-640 Titul I.		x				x									x					x	
Flower Pot I.									6												
EM-650 Lost Islands		x							x	x					x	x					
EM-660 Helmet I.									x											x	
Haswell I.						x			x		x				x					x	x
EM-690 Reef Island		x	x	x		x			x	x	x			x	x	x					x
EM-700 South Low I.		x							3						x						
EM-710 Vertical Point	2	x	x	x	x		x		17	2	x			1n	x	x				x	x
EM-720 Limestone Is.									x	2				x	x						
EM-730 Low Island		x							x						x						
EM-740 Skedans Is.		x		x		x	x		1n						x					x	

Appendix V. cont'd

		OCWA	TOWA	WIWA	SAVS	FOSP	SOSP	GCSP	DEJU	RECR	PISI	PHDA	EUJU	PHVT	CAUR	LUCA	ODHE	PRLO	RARA
EM-010	Kunghit I.	x	x	x		x	x			x	x			28		x	x		
EM-020	Marshall I.															x			
EM-050	High Island	x	x							x				1		x	x		
EM-070	Charles I.													1		x			
	Ellen Island															x	x		
	Rose Island															x	x	x	
EM-090	Garcin Rocks													19					
EM-100	Langtry Island										x			3		x			
EM-120	Rankine Is.		x			x	In		x	x	x					x	x		
EM-140	West Islets															x			
EM-160	Joyce Rocks													10					
EM-170	Sea Pigeon I.						x									x	x	x	
EM-180	Boulder I.						x										x	x	
EM-210	Bush Rock						x										x		
EM-220	Bolkus Is.	x	x				x							1			x		
EM-230	Swan Islands						x									x	x	x	
EM-250	Slug Islet													57					
EM-260	Rock Islet					x	x							4					
EM-270	Skincuttle I.		x		x	x				x			1	22		x	x		
EM-280	George I.	x	x				x			x	x		1	18		x	x		
EM-290	Jeffrey I.									x						x			
EM-300	East Copper I.	x	x			x	x				x			20		x	x		
EM-310	Howay Island						x									x			
	Burnaby Island	x	x															1	
EM-340	Centre Islet						x									x		S	
EM-350	Wanderer I.															x	x	S	
EM-360	Sels Islet						x							10		x		S	
EM-370	Park Island															x			
EM-380	Koga Island															x			
EM-390	Nakons It.						x												
EM-400	Alder I.		x							x				1		x	x		
EM-410	Huxley I.		x							x						x	x	S	
EM-420	Arichika I.	x	x				x							1		x	x		
EM-450	Hoskins Its						x									x			
	Sivart Island		x				x									x			
	De La Beche I.															2			
EM-460	Tatsung Rock													13					
EM-470	Ramsay Island	x	x	x	x	x	x		x	x	x			61		x	x		
EM-490	Bischof Is.						x									x	x	S	
EM-500	Hotspring I.	x	x			x	x				x					x			
EM-510	House I.		x																
EM-520	Kloo Rock						x									x	x		
EM-530	Murchison I.		x											15		x	x		x
	Faraday I.	x	x													x	x		
EM-540	Agglomerate I.	x	x				x				x			10		1			
EM-550	Kawas Is.	x	x							x						x	x		
EM-560	Tar Islands	x					x			x				135		x			
	Skags Island						x												
EM-570	Tuft I.						x												
EM-580	Lyell Island	x	x	x			x	x		x	x	5			1	2	x		x
EM-620	Kul Rocks													4					
	Kunga Island	x	x							x				1		x			
EM-640	Titul I.	x				x	x									x	x		
	Flower Pot I.		x				x							15			x		
EM-650	Lost Islands	x				x								20		x			
EM-660	Helmet I.						x							1		x	x		
	Haswell I.									x						x		2	
EM-680	Kingsway Rock															x			
EM-690	Reef Island	x	x			x	x						136+	12		1	x		
EM-700	South Low I.	x	x			x	x							3					
EM-710	Vertical Point	x	x	x					x	x	x			1				S	
EM-720	Limestone Is.	x				x										x	x	?	
EM-730	Low Island	x	x			x	x						1			x			
EM-740	Skedans Is.	In	In			x	In						161	28		x			
EM-790	Cumshewa I.													30					

APPENDIX VI. Index to species names and acronyms.

Birds:		
Pacific Loon	Gavia arctica	PALO
Common Loon	G. immer	COLO
Horned Grebe	Podiceps auritus	HOGR
Red-necked Grebe	P. grisegena	RNGR
Northern Fulmar	Fulmaris glacialis	NOFU
Sooty Shearwater	Puffinus griseus	SOSH
Fork-tailed Storm-Petrel	Oceanodroma furcata	FTSP
Leach's Storm-Petrel	O. leucorhoa	LSPE
Double-crested Cormorant	Phalacrocorax auritus	DCCO
Pelagic Cormorant	P. pelagicus	PECO
Great Blue Heron	Ardea herodias	GBHE
Brant	Brant bernicla	BRAN
Canada Goose	B. canadensis	CAGO
Green-winged Teal	Anas crecca	GWTE
Mallard	A. platyrhynchos	MALL
Northern Shoveller	A. clypeata	NOSL
Greater Scaup	Aythya marila	GRSC
Harlequin Duck	Histrionicus histrionicus	HADU
Surf Scoter	Melanitta perspicillata	SUSC
White-winged Scoter	M. fusca	WWSC
Bufflehead	Bucephala albeola	BUFF
Common Merganser	Mergus merganser	COME
Red-breasted Merganser	M. serrator	RBME
Bald Eagle	Haliaeetus leucocephalus	BAEA
Sharp-shinned Hawk	Accipiter striatus	SSHA
Red-tailed Hawk	Buteo jamaicensis	RTHA
Peregrine Falcon	Falco peregrinus	PEFA
Blue Grouse	Dendragapus obscurus	BLGR
Lesser Golden Plover	Pluvialis dominica	LGPL
Black Oystercatcher	Haematopus bachmani	BLOY
Greater Yellowlegs	Tringa melanoleuca	GRYE
Wandering Tattler	Heteroscelus incanus	WATA
Black Turnstone	Arenaria melanocephala	BLTU
Common Snipe	Gallinago gallinago	COSN
Parasitic Jaeger	Stercorarius parasiticus	PAJA
Herring Gull	Larus argentatus	HEGU
Thayer's Gull	L. thayeri	THGU
Glaucous-winged Gull	L. glaucescens	GWGU
Black-legged Kittiwake	Rissa tridactyla	BLKI
Sabine's Gull	Xema sabini	SAGU
Common Murre	Uria aalge	COMU
Pigeon Guillemot	Cepphus columba	PIGU
Marbled Murrelet	Brachyramphus marmoratus	MAMU
Ancient Murrelet	Synthliboramphus antiquus	ANMU
Cassin's Auklet	Ptychoramphus aleuticus	CAAU
Rhinoceros Auklet	Cerorhinca monocerata	RHAU
Tufted Puffin	Fratercula cirrhata	TUPU
Snowy Owl	Nyctea scandiaca	SNOW
Northern Saw-whet Owl	Aegolius acadicus	NSWO
Belted Kingfisher	Ceryle alcyon	BEKI
Rufous Hummingbird	Selasphorus rufus	RUHU

APPENDIX VI. continued

Red-breasted Sapsucker	Sphyrapicus ruber	RBSA
Hairy Woodpecker	Picoides villosus	HAWO
Northern Flicker	Colaptes auratus	NOFL
Western Flycatcher	Empidonax difficilis	WEFL
Tree Swallow	Tachycineta bicolor	TRSW
Barn Swallow	Hirundo rustica	BASW
Northwestern Crow	Corvus caurinus	NWCR
Common Raven	C. corax	CORA
Chestnut-backed Chickadee	Parus rufescens	CBCH
Bushtit	Psaltriparus minimus	BUSH
Red-breasted Nuthatch	Sitta canadensis	RBNU
Brown Creeper	Certhia americana	BRCR
Winter Wren	Troglodytes troglodytes	WIWR
Golden-crowned Kinglet	Regulus satrapa	GCKI
Ruby-crowned Kinglet	R. calendula	RCKI
Townsend's Solitaire	Myadestes townsendi	TOSO
Swainson's Thrush	Catharus ustulatus	SWTH
Hermit Thrush	C. guttatus	HETH
Varied Thrush	Ixoreus naevius	VATH
Orange-crowned Warbler	Vermivora celata	OCWA
Townsend's Warbler	Dendroica townsendi	TOWA
Wilson's Warbler	Wilsonia pusilla	WIWA
Savannah Sparrow	Passerculus sandwichensis	SAVS
Fox Sparrow	Passerella iliaca	FOSP
Song Sparrow	Melospiza melodia	SOSP
Golden-crowned Sparrow	Zonotrichia atricapilla	GCSP
Dark-eyed Junco	Junco hyemalis	DEJU
Red Crossbill	Loxia curvirostra	RECR
Pine Siskin	Carduelis pinus	PISI

Mammals:

Dall's Porpoise	Phocoenoides dalli	PHDA
Northern Sea Lion	Eumetopias jubatus	EUJU
Hair Seal	Phoca vitulina	PHVT
Northern Fur Seal	Callorhinus ursinus	CAUR
River Otter	Lutra canadensis	LUCA
Sitka Deer	Odocoileus lemionus	ODHE
Raccoon	Procyon lotor	PRLO
Black Rat	Rattus rattus	RARA

APPENDIX VII. Sample transect form and data entry codes.

DATA ENTRY CODES FOR TRANSECT RECORDS

BURROW LOCATION AND ENTRANCE CLASS

1 - under tree
2 - live tree roots
3 - under stump
4 - dead tree roots
5 - fallen tree - log
6 - rock
7 - grass tussock
8 - open ground
9 - into bank
10 - shrubbery
11 - dense herbage
12 - driftwood

a - open/clear approach
b - open/obscure approach
c - obstructed/clear approach
d - obstructed/obscured approach
w - well-like

LENGTH OF BURROW

> arm - couldn't reach end
0.x - measurement to nest from entrance (in m.)

SIGNS AT BURROW ENTRANCE

d - droppings (fecal)
e/ef - eggshell fragments
eh - hatched eggshell
ep - predated eggshell
em - eggshell membrane
f - feathers
g - regurgitated food
k - worn entrance
fd - fresh digging

CONTENTS OF BURROW

FTSP - Fork-tailed Storm Petrel
LSPE - Leach's Storm Petrel
TUPU - Tufted Puffin
RHAU - Rhinoceros Auklet
CAAU - Cassin's Auklet
ANMU - Ancient Murrelet
U/UNK - Unknown
E - egg
emp - empty
k - worn tunnel

SIGNS OF PREDATION

fp - feather pile
pel - pellet
ep - predated eggshell
w - single wing
pw - attached pair of wings
c - carcass
ic - inverted carcass
dc - decapitated carcass
dug - dug-up burrow

GROUND COVER

g - grass
m - moss
bg - bare ground
r - rock
md - mossy deadfall
tb - tree base
st - stump
w - wet seepage/water
ss - spruce seedlings (0.5 m. high)
hs - hemlock seedlings
ur - upturned roots
bl - branch litter
wd - windfall debris
br - beach rock
J - juncus
sf - sword fern

SHURB COVER - dbh - <15 cm. height - >0.5 m.

H - Hemlock
S - Sitka Spruce
sa - salal
sb - salmonberry
hu - huckleberry (Vaccinium sp.)
tw - twinberry
el - elderberry
cb - copperbush
fa - false azalea
ca - crabapple
cur - currant

FOREST COVER

S - Sitka Spruce
H - Western Hemlock
C - Red Cedar
A - Alder
Ca - crabapple

TRANSECT RECORD

ISLAND _____ OBSERVERS _____

TRANSECT # _____ DATE _____

LOCATION _____ TIME _____

BEARING _____ PICTURE _____

Pt. # DISTANCE ALONG TRANSECT Quadrat size - SLOPE ELEVATION

Burrow #	Locat. & Ent. Class	Signs at Ent.	Contents	Length (m.)	VEGETATION OF PLOT Ground cover	Shrub cover Sp.& %	Height	Forest cover %Can&Sp	dbh	Signs of pred in plot
1										
2										
3										
4										

Pt. # DISTANCE ALONG TRANSECT Quadrat size - SLOPE ELEVATION

Burrow #	Locat. & Ent. Class	Signs at Ent.	Contents	Length (m.)	VEGETATION OF PLOT Ground cover	Shrub cover Sp.& %	Height	Forest cover %Can&Sp	dbh	Signs of pred in plot
1										
2										
3										
4										

Pt. # DISTANCE ALONG TRANSECT Quadrat size - SLOPE ELEVATION

Burrow #	Locat. & Ent. Class	Signs at Ent.	Contents	Length (m.)	VEGETATION OF PLOT Ground cover	Shrub cover Sp.& %	Height	Forest cover %Can&Sp	dbh	Signs of pred in plot
1										
2										
3										
4										

Notes - HABITAT, PREDATION, OTHER

Appendix VII. cont'd